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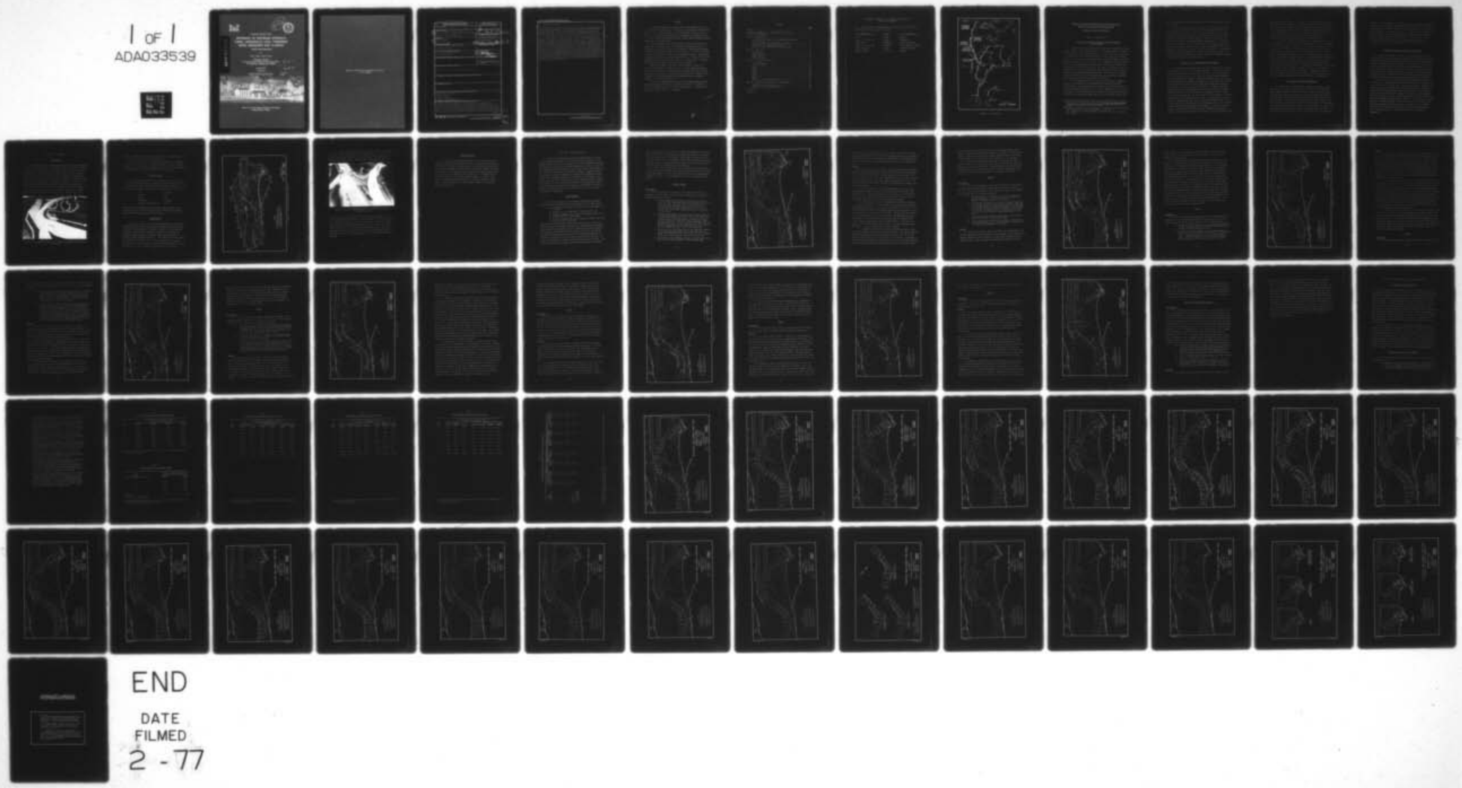

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TECHNICAL REPORT H-76-19

ENTRANCE TO UPSTREAM APPROACH CANAL, GAINESVILLE LOCK, TOMBIGBEE RIVER, MISSISSIPPI AND ALABAMA

Hydraulic Model Investigation

by

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Final Report

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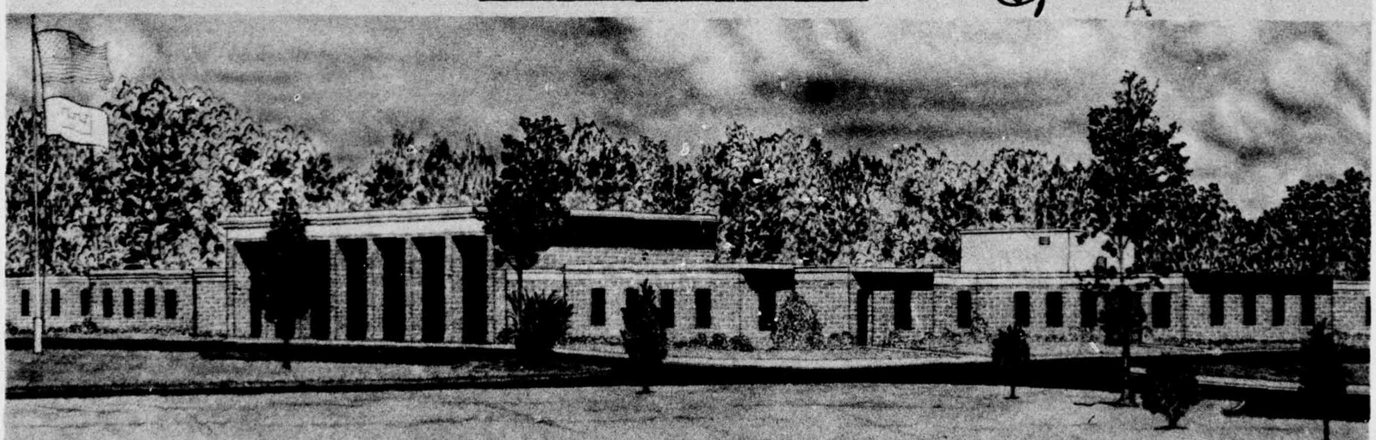

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As part of the program for the development of navigation on the Tennessee-Tombigbee Waterway, the Gainesville Lock and Dam will be the first navigation structure proposed for the development of the waterway. The lock will be in a bypass canal about 266 miles above the mouth of the Mobile River, which is at the foot of Government Street in Mobile, Alabama, or approximately 49 miles above the confluence of the Tombigbee and Warrior Rivers and 53 miles
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20. ABSTRACT (Continued).

above Demopolis Lock and Dam. The structure is designed to maintain during low flows a minimum upper pool extending upstream to the proposed Aliceville Lock and Dam at mile 332.6. The project will include one lock with clear chamber dimensions of 110 by 600 ft located in a bypass canal on the left overbank and a dam consisting of a gated spillway and fixed overflow section.

A fixed-bed model reproduced about 2.6 miles of the Tombigbee River channel, about 3000 ft of the upstream end of the navigation canal, and the adjacent overbank areas to an undistorted scale of 1:100. The model investigation was concerned with the development of good navigation conditions at the entrance to the approach canal and in the two bends just upstream of the entrance to the canal, and in the distribution of flow through the gated spillway. Results of the investigation revealed the following: (a) Satisfactory navigation could be developed at the entrance to the lock approach canal by modification of the excavation along the left bank and in the bend adjacent to the canal. (b) Satisfactory navigation conditions for two-way traffic through the reach could be provided under most conditions by the excavation mentioned in (a) above, by increasing channel width, and by improving the curvature of the second bend upstream of the canal. (c) Improving the distribution of flow through the gated spillway with a training wall would have little effect on water-surface elevations upstream.

PREFACE

The model investigation reported herein was authorized by the Office, Chief of Engineers, U. S. Army, in an indorsement dated 20 April 1970, to the Division Engineer, U. S. Army Engineer Division, South Atlantic. The study was conducted in the Hydraulics Laboratory of the U. S. Army Engineer Waterways Experiment Station (WES) during the period August 1971 to December 1972.

The investigation was conducted under the general supervision of Messrs. H. B. Simmons, Chief of the Hydraulics Laboratory, and F. A. Herrmann, Jr., Assistant Chief of the Hydraulics Laboratory; and under the direct supervision of Messrs. J. J. Franco and J. E. Glover, retired Chief and Chief, respectively, of the Waterways Division. The engineer in immediate charge of the model study was Mr. L. J. Shows, Chief of the Navigation Branch, assisted by Messrs. C. R. Nickles and R. T. Wooley. This report was prepared by Messrs. Shows and Franco.

During the course of the model study, Messrs. W. Odom, A. F. Baer, B. Felder, and F. Thompson of the U. S. Army Engineer District, Mobile, visited WES at different times to observe special model tests and discuss the results. The Mobile District was kept informed of the progress of the study through monthly progress reports and special reports at the end of each test.

Directors of WES during the course of the investigation and the preparation and publication of this report were COL L. A. Brown, CE, BG E. D. Peixotto, CE, COL G. H. Hilt, CE, and COL J. L. Cannon, CE. Technical Director was Mr. F. R. Brown.

CONTENTS

CONVERSION FACTORS, U. S. CUSTOMARY TO METRIC (SI) UNITS OF MEASUREMENT

U. S. customary units of measurement used in this report can be converted to metric (SI) units as follows:

Multiply	By	To Obtain
feet	0.3048	metres
miles (U. S. statute)	1.609344	kilometres
square miles	2.589988	square kilometres
cubic feet per second	0.02831685	cubic metres per second
feet per second	0.3048	metres per second
degrees (angle)	0.01745329	radians

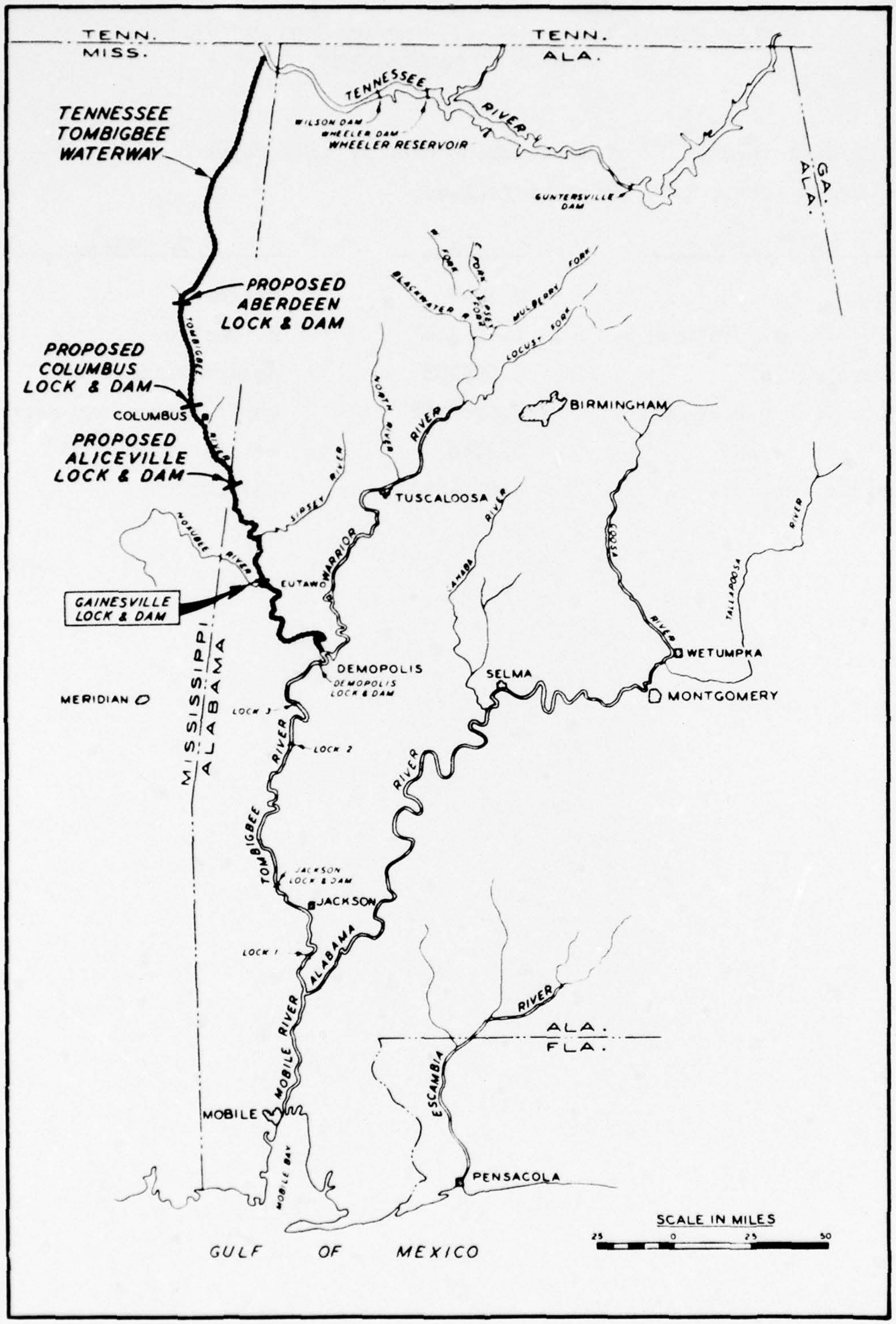

Figure 1. Vicinity map

ENTRANCE TO UPSTREAM APPROACH CANAL, GAINESVILLE LOCK, TOMBIGBEE RIVER, MISSISSIPPI AND ALABAMA

Hydraulic Model Investigation

PART I: INTRODUCTION

Location of Proposed Lock and Dam and Description of Prototype*

1. Gainesville Lock and Dam are proposed for construction in west-central Alabama on the Tombigbee River, 1.5 miles** northeast of Gainesville in Green County, Alabama (Figure 1). The lock will be constructed in a bypass canal about 266 river miles above the Mobile River mouth, which is at the foot of Government Street in Mobile, Alabama, or approximately 49 miles above the confluence of the Tombigbee and Warrior Rivers and 53 miles above Demopolis Lock and Dam. About 6 miles farther upstream, the dam will be placed across the main river channel. This lock and dam will be the first navigation structure proposed for the development of the Tennessee-Tombigbee Waterway. The structure is designed to maintain during low flows a minimum upper pool extending upstream to the proposed Aliceville Lock and Dam at mile 332.6.

2. The Tombigbee River above the proposed Gainesville damsite drains a 7142-square-mile area, approximately 130 miles long and 80 miles wide. The drainage area lies within the Coastal Plains with elevations ranging from about 1000 ft† at the highest point to 70 ft at the damsite. The Tombigbee River is formed at the junction of the East and West Forks near Amory, Mississippi, and flows 59 miles nearly due

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* Prototype information was obtained from Gainesville Lock and Dam, Tombigbee River, Mississippi and Alabama, Design Memorandum Nos. 1 and 8.

** A table of factors for converting U. S. customary units of measurement to metric (SI) units is presented on page 3.

† All elevations (el) cited herein are in feet referred to mean sea level (msl).

south to Columbus, Mississippi, thence 81 miles southeast to the Gainesville damsite.

3. The ridge separating the Tennessee River from the headwaters of the Tombigbee is about 15 miles south of the Tennessee River in extreme northeast Mississippi. The ridge divides the waters of Yellow Creek, which flows northward into the Tennessee River, from the waters of Mackeys Creek, which flows southward to the East Fork of the Tombigbee. The proposed Tennessee-Tombigbee project will cut a channel through this divide to el 395.0 and connect these rivers for navigation by means of locks and dams. At low stages, the Tombigbee River varies in width from 75 ft at its source to 400 ft at Demopolis. The principal tributaries of the Tombigbee River above the Gainesville damsite are the East and West Forks which form the stream, the Buttahatchee, Tibbee, and Sipsey Rivers, and Luxapalila Creek.

Present Plan of Improvement and Development

4. The Tennessee-Tombigbee project, first authorized in the 1946 River and Harbor Act, consists of three reaches: the river section, the canal section, and the divide section. The river section will consist of a 168-mile-long reach of river which will extend up the Tombigbee River from Demopolis, Alabama, to Amory, Mississippi, and will involve straightening the river channel and building conventional locks and dams near Gainesville and Aliceville, Alabama, and Columbus and Aberdeen, Mississippi. The canal section will consist of a 45-mile-long canal which will parallel the Tombigbee River on the east from near Amory to Mackeys Creek near Old Bay Springs in the southwest corner of Tishomingo County, Mississippi, and will involve the construction of a canal, by excavation and levees, with five locks. The divide section will consist of a 40-mile-long canal that will extend from Bay Springs to the Yellow Creek arm of Pickwick Lake on the Tennessee River near the common boundary of Mississippi, Alabama, and Tennessee, involving a 27-mile-long cut through the divide separating the Tombigbee and Tennessee basins. The river section will be a minimum of 9 ft deep, and the canal

and divide sections will be 12 ft deep. The bottom width will be 300 ft except in the actual divide cut, where it will be 280 ft. The lock chambers, with clear dimensions of 110 by 600 ft, will have a depth of 15 ft over the miter gate sills, corresponding to the new locks on the connecting waterways. The locks will provide a total lift of 341 ft to overcome the difference in elevation between Demopolis Lake on the Tombigbee River and Pickwick Lake on the Tennessee River.

5. The major portion of the prospective commerce consists of upbound movement of commodities which normally move in bulk. Virtually all the upbound commerce originates in the immediate trade areas of the Gulf ports or at industries or producing areas along the Gulf Intracoastal Waterway. Upbound traffic originating at New Orleans or west thereof would terminate generally along the upper Tennessee River; traffic originating at Mobile or ports to the east, owing to the greater distance advantage in comparison with the Mississippi River, would be distributed over a much broader area along the Ohio and the upper Mississippi River and tributaries. Similarly, a large part of the downbound traffic would terminate along the Gulf Coast or be exported through the ports of Mobile or New Orleans. Shippers and receivers along the Warrior River, principally Tuscaloosa and Birmingham, would also contribute an appreciable volume of traffic to the waterway.

Description of Proposed Structures

6. Gainesville Lock and Dam are designed to maintain a normal upper pool at el 109.0. The lock will be located in a 2-mile-long canal bypassing about 6 miles of the river channel. The dam consists of a gated spillway to be located on the right overbank and a fixed crest spillway to be located across the river channel adjacent to the gated spillway. The dam will be connected to the right bank with an overflow dike, having a top elevation of 120.0 adjacent to the abutment and sloping down to el 114.0 along the right overbank. The crest of the dike will serve as an access road to the dam from the right bank. A nonoverflow dike with top at el 134.0 will extend from the left side of

the dam to the right bank of the navigation canal and then downstream to the lock. The slack-water navigation canal containing the lock will be excavated across the left overbank to a bottom elevation of 96.0 and width of 300 ft. A dike with top at el 123.0 will be constructed along the left bank of the canal to prevent the overbank flow from moving across the canal during the higher flows. The lock near the downstream end of the canal will have clear chamber dimensions of 110 by 600 ft and will provide a maximum lift of 36 ft from el 73.0 to 109.0.

Need for, Scope, and Purpose of Model Study

7. The general design of Gainesville Lock and Dam was based on sound theoretical design practice and experience with similar structures. However, navigation conditions vary with location and flow conditions upstream and downstream of a structure, and an analytical study to determine the hydraulic effects that can reasonably be expected to result from a particular design is both difficult and inconclusive. Thus, a comprehensive model study was considered necessary to investigate conditions that could be expected with the proposed design and to develop modifications required to ensure satisfactory navigation conditions.

8. The locations of the dam and the upper entrance to the navigation canal were fixed downstream of the second bend of an S-shaped curve in the river at the time the model study was undertaken. Therefore, the specific purpose of the model was not only to investigate navigation conditions in the bends upstream and at the entrance to the navigation canal and flow conditions and discharge distribution at the dam with various riverflows, but also to develop modifications that might be required to eliminate any undesirable conditions. In addition, the model was used to determine stages, current directions, and velocities with the dam and navigation canal in place, to demonstrate to navigation interests the conditions resulting from the proposed design, and to satisfy these interests of its acceptability from a navigation standpoint.

PART II: THE MODEL

Description

9. The model (Figure 2) reproduced about 2.6 miles of the Tombigbee River, extending from just downstream of the dam to about 1.6 miles upstream of the entrance to the navigation canal. Also included were about 3000 ft of the upstream end of the navigation canal, the gated- and fixed-crest sections of the dam, and the adjacent overbank areas. The model was of the fixed-bed type, with the channel and overbank areas molded in sand-cement mortar to sheet metal templets. Portions of the model, where changes in bank alignments and channel configurations could be anticipated, were molded in pea gravel to permit modifications that might be required to provide satisfactory conditions. The dam crest and piers were fabricated of sheet metal. The dam gates were

Figure 2. General view of the model showing the entrance to the canal and the dam

simulated schematically with simple sheet metal slide-type gates. The lock was not included within the model limits.

10. The model was molded to the hydrographic and topographic survey made in August 1971. Overbank areas were molded to a maximum elevation of 115.0 which was considered sufficient for the reproduction and investigation of flows that would affect navigation.

Scale Relations

11. The model was built to an undistorted linear scale ratio of 1:100, model to prototype, to obtain accurate reproduction of velocities, crosscurrents, and eddies that would affect navigation. Other scale ratios resulting from the linear scale ratio were as follows:

Area	1:10,000
Velocity	1:10
Time	1:10
Discharge	1:100,000
Roughness (Manning's n)	1:2.15

Measurements of discharges, water-surface elevations, and current velocities can be transferred quantitatively from model to prototype equivalents by means of these scale relations.

Appurtenances

12. Water was supplied to the model by means of a circulating comprehensive water supply system; the discharge was controlled and measured at the upper end of the model by means of a valve and venturi meter. Water-surface elevations were measured by means of piezometer gages located in the model channel and connected to a centrally located gage pit (Figure 3). For control riverflows, upper pool stages were controlled at the dam by opening and closing the slide gates; for open riverflows, tailwater elevations were controlled by means of a tailgate located at the lower end of the model.

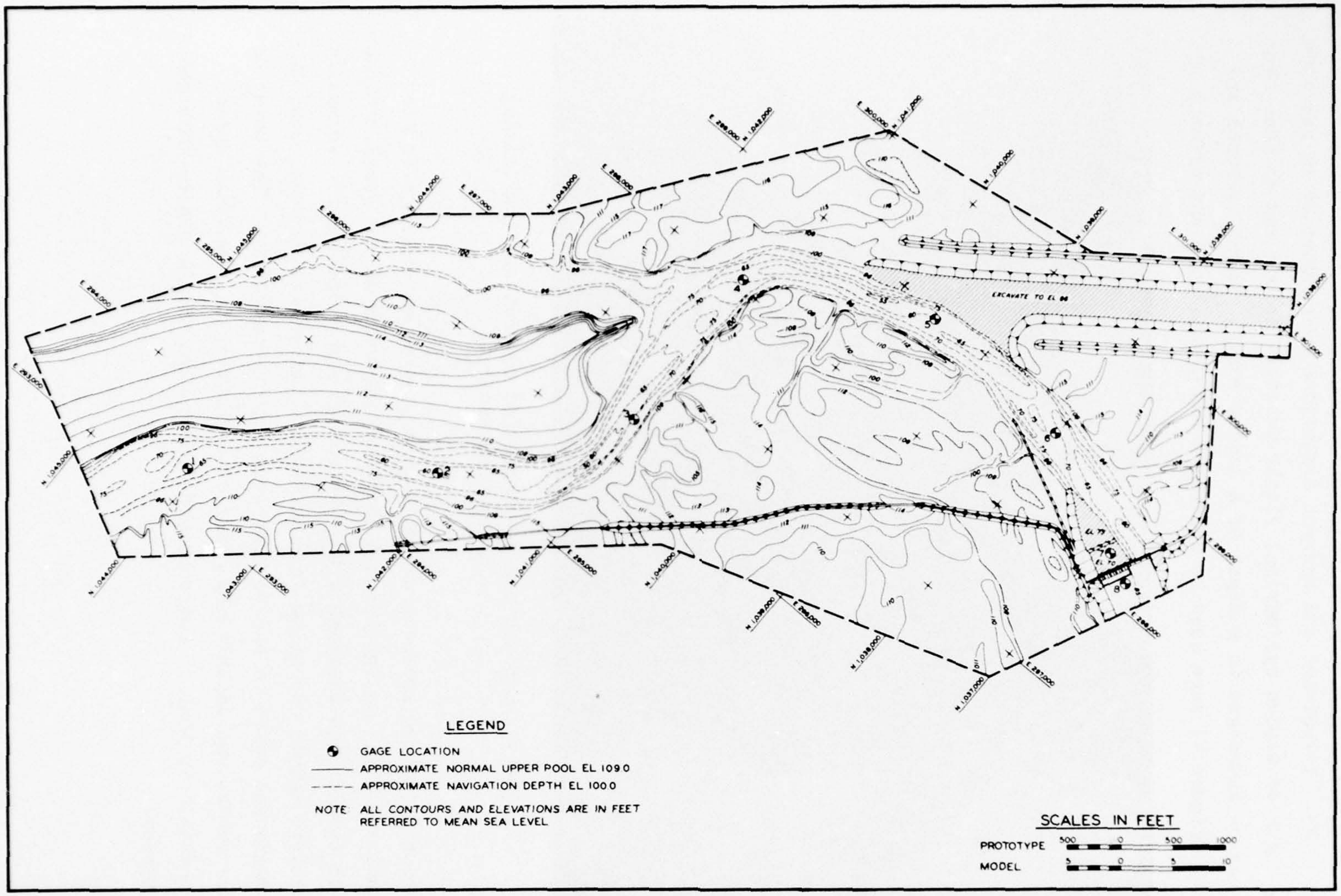


Figure 3. Model layout and gage locations

13. Velocities and current directions were obtained in the model by means of wooden cylindrical floats weighted on one end so that they would be submerged to a depth of a loaded barge. Model towboats and tows (Figure 4) were used to determine and demonstrate the effects of

Figure 4. Upbound remote-controlled towboat and tow leaving navigation canal

currents on tows approaching and leaving the upper entrance to the canal and while moving through the bends upstream of the canal entrance. Each towboat was equipped with twin screws and propelled by two small electric motors operating from batteries located in the model tow; the rudders and speed of the towboat were remote-controlled. The power of the towboat was adjusted by means of a rheostat to a maximum speed comparable to that of towboats expected to use the Tennessee-Tombigbee Waterway.

Model Adjustment

14. Inclusion of the proposed plans in the initial model construction precluded adjustment of the model to the existing prototype conditions. This type of adjustment was not considered necessary since the proposed improvements would involve considerable change from existing conditions. The model was constructed with a brushed-cement mortar finish to provide a roughness factor (Manning's n) of about 0.0135, which corresponds to a prototype channel roughness of about 0.029. Based on experience with other models of this type, brushed concrete gives a close approximation of the roughness required to reproduce prototype conditions.

PART III: TESTS AND RESULTS

15. Tests on the model were concerned primarily with the study of flow patterns, measurement of velocities near the entrance to the navigation canal and in the two bends in the river immediately upstream, and behavior of the model tows moving through this reach of the river and in approaching and entering the canal under various flow conditions. Tests were also conducted to determine the changes in channel widths and radius of curvature required in the bends for one-way and two-way traffic and to develop modifications required at the entrance to the canal. Since the worst conditions, as far as navigation was concerned, were obtained in the model during the higher river stages with uncontrolled riverflows, no tests were conducted to determine the effects of dam gate operation during controlled flows except with all spillway gates open the same amount.

Test Procedure

16. Tests were conducted by reproducing stages and discharges that provided the following flow conditions with the original design:

- a. A controlled riverflow of 30,000 cfs at normal upper pool el 109.0.
- b. Maximum flow at normal pool el 109.0 (64,500 cfs).
- c. Maximum navigable flow (3-1/2-yr frequency, 97,000 cfs), tailwater el 114.3 at the dam.
- d. Flood of January 1949 (12-yr frequency, 148,000 cfs) tailwater el 118.7 at the dam.

The controlled riverflow was obtained by introducing the proper discharge, setting the tailwater elevation for the discharge, and manipulating the dam gate openings until the required upper pool elevation was obtained. Uncontrolled riverflows were obtained by introducing the proper discharge with dam gates fully open and manipulating the tailgate to obtain the proper tailwater elevation below the dam. All stages were permitted to stabilize before any data were recorded. Current directions were determined by plotting the paths of the wooden

floats (paragraph 13) with respect to ranges established for that purpose, and velocities were measured by timing the travel of the floats over known distances. No data were obtained with the model tow other than the observations of its behavior in the bends, canal entrance, and critical reaches. Flow distributions through the gated spillway were based on velocity measurements in each gate bay.

17. Most of the modifications were developed during preliminary tests. Data obtained during these tests were sufficient only to assist in the development of a plan that appeared to provide the improvements required. Results of the preliminary tests are not included in this report.

Original Design

Description

18. The original plan proposed for the dam and for the upper approach to the navigation canal is shown in Figure 5 and includes the following principal features:

a. A nonnavigable gated spillway, located in an excavated section of the right bank about 3000 ft downstream of the canal entrance, contained six 8-ft-wide piers and five 50-ft gate bays with gate sills at crest el 75.0. A 225-ft-long overflow weir with crest at el 108.5 was across the river channel between the gated spillway and the left bank.

b. A 2-mile-long bypass navigation canal, which included the lock, excavated along the left overbank. The canal had a 300-ft-bottom width at el 96.0. Only about 2750 ft of the upper end of the canal and the entrance were reproduced in the model. Earth-fill dikes along both sides of the canal had crest el 123.0 along the left bank, el 120.0 along the right bank for the upper 1700 ft, and el 134.0 for the remaining portion of the dike downstream.

c. The left end of the overflow weir of the dam was connected to the dike along the right side of the canal with an earth-fill dike having a crest elevation of 134.0. These dikes also served as access roads to the structures.

d. An earth-fill dike extended upstream along the right overbank from the right abutment of the gated spillway.

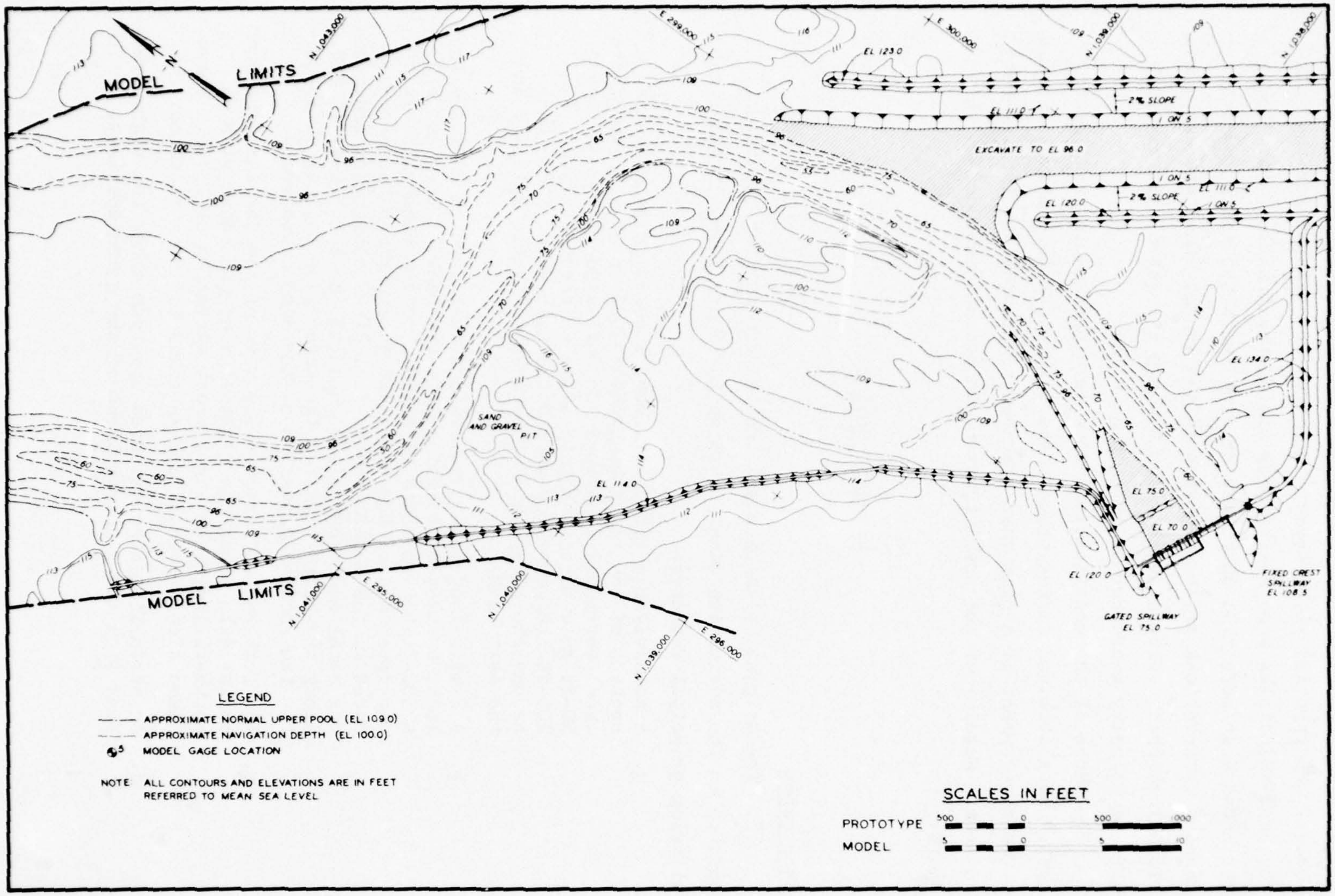


Figure 5. Original design

The dike had a crest elevation of 120.0 for the first 500 ft from the spillway then sloped down to el 114.0, extending generally in a westerly direction across the right overbank to high ground. The low portion of the dike would serve as an overflow weir and as an access road to the dam.

Results

19. The results shown in Table 1 indicate that with the original plan the drop in water-surface elevation in the little more than 2-mile reach of the river upstream of the dam (gages 1-7) varied from 1.0 ft with 64,500-cfs flow to 1.2 ft with 148,000-cfs flow. The drop in water levels through the dam (gages 7-8) ranged from about 0.6 to 0.7 ft before the dike along the right overbank was overtopped and somewhat less after overtopping.

20. The distribution of flow through the gated section of the dam was generally good except for the gate bay adjacent to the fixed weir (Table 2). This was attributed to the location of the fixed weir across the main channel forcing a large portion of the total flow to move toward the right to pass through the gated spillway.

21. Currents with flows tested generally followed the alignment of the channel (Plates 1-3). The highest velocities affecting navigation ranged from about 3.5 fps with the 30,000-cfs flow to about 7.6 fps with the 97,000-cfs flow. The highest velocities were measured in the bends upstream of the entrance to the canal. Currents near the entrance to the canal were affected by the sharp bend just upstream causing a concentration of flow and higher velocities along the approach side of the channel, particularly with the higher flows. There was a tendency for a counterclockwise eddy to form in the canal entrance which increased in size and intensity with river discharge.

22. Navigation conditions for downbound tows entering the canal could be extremely difficult and hazardous because of the higher velocity currents moving across the entrance and the need for the tow to turn into the canal leaving its stern exposed to the currents. Furthermore, the difficulty in navigating through the bend just upstream and becoming aligned along the bank for a satisfactory entrance to the canal would

make it necessary for the tows to enter the canal approaching closely along the left bank upstream of the entrance. Because of the set of the currents, sharp turns, and limited channel width, navigation for downbound tows was also not good in the bends upstream of the entrance.

23. Upbound tows with sufficient power to overcome the higher current velocities could leave the canal and navigate through the bends without any serious difficulties. Observations with the original plan indicate that two-way traffic would not be possible through the reach during most flows and could be difficult during some low flows.

Plan A

Description

24. Plan A was developed to eliminate the difficulties that would be encountered by downbound tows approaching the canal as observed in the test of the original design. This plan was the same as the original design except for the following (Figure 6):

- a. The right bank of the navigation canal was extended upstream about 600 ft to the river channel reducing the amount of dredging required on that side.
- b. The left bank of the canal was flared landward 8 deg from its original alignment, starting about 1000 ft downstream of the upper end of the right bank as modified, and curved into the main channel as shown in Figure 6. The top bank of the curve was maintained at an elevation of at least 111.0 with a dike forming an upstream extension of the curve.
- c. The earth-fill dike along the left bank of the canal was flared to conform to the realigned bank.
- d. The right bank of the bend just upstream of the canal entrance was excavated to el 96.0 to increase channel width and improve the alignment of the bend.

Results

25. The results shown in Table 3 indicate that water-surface elevations upstream of the canal entrance were somewhat lower than with the original design with the 64,500-cfs flow and about the same with the 97,000-cfs flow. The total drop in water-surface elevations in the

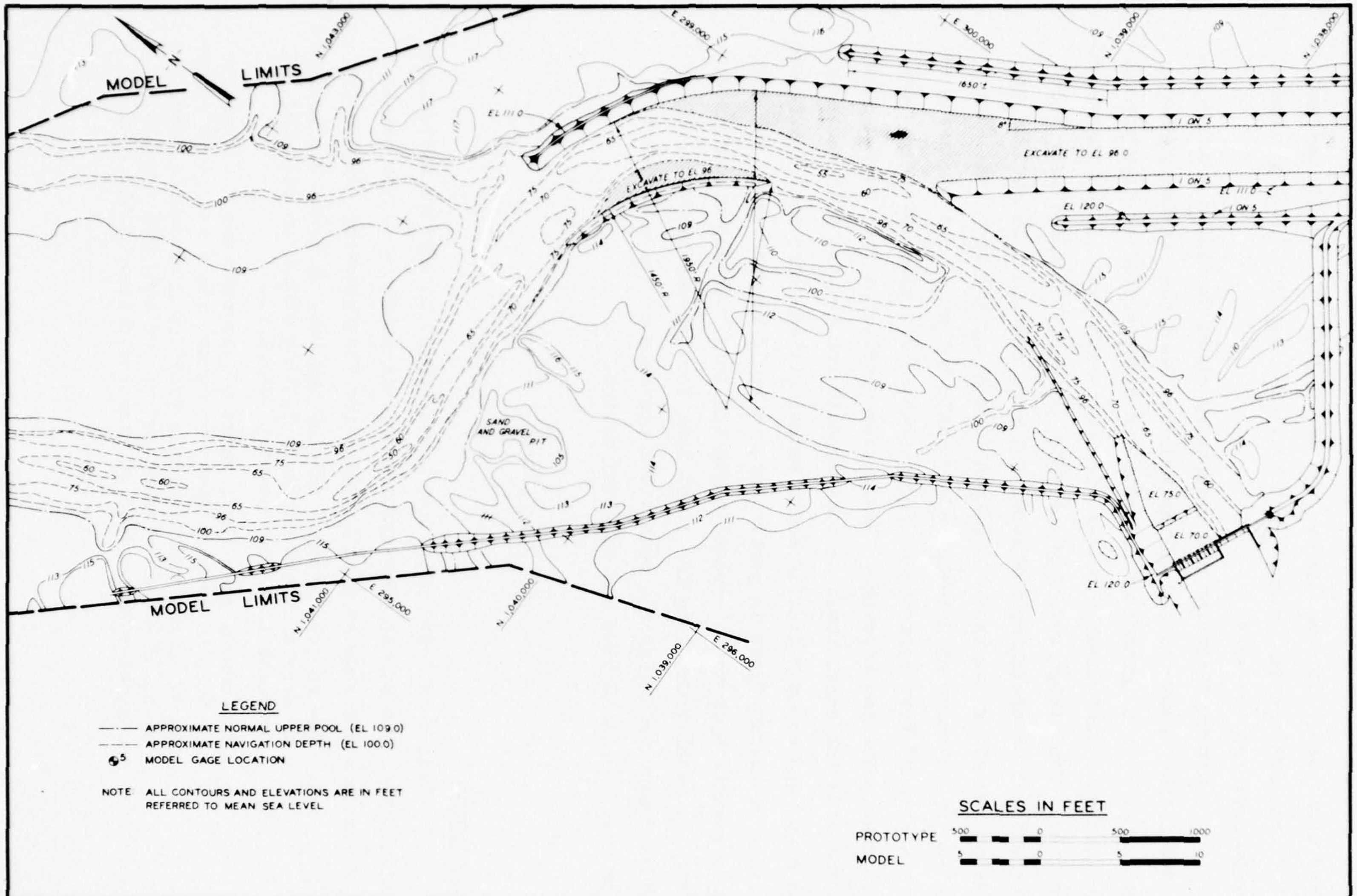


Figure 6. Plan A

reach upstream of the dam (gages 1-7) was 0.9 and 1.1 ft and 0.6 and 0.7 ft through the dam (gages 7 and 8) with flows of 64,500 cfs and 97,000 cfs, respectively.

26. Current direction and velocities shown in Plates 4 and 5 indicate little change except in the modified bend near the entrance to the canal. The alignment of currents and distribution of flow through the bend were considerably better with some reduction in the higher velocities. The higher velocity currents were some distance away from the left bank approaching the canal entrance and could be avoided by tows moving along the bank. Currents from along the left bank moved across the entrance at a rather sharp angle but would not adversely affect downbound tows approaching the entrance from along the left bank with some power and steerage. Navigation conditions for downbound tows approaching the canal would be considerably better than with the original plan, and two-way traffic could be maintained under most conditions. During the higher flows in particular, it would be much safer for downbound tows to approach the canal along the left bank and upbound tows to leave the canal from along the right bank for two-way traffic. There was no change in navigation conditions upstream of the modified bend from that indicated with the original design.

Plan B

Description

27. Plan B included modifications designed to improve navigation conditions in the second bend upstream of the entrance to the canal. This plan was the same as plan A except for the following (Figure 7):

a. The concave (right) bank of the bend upstream was modified to form a smooth curve by filling along the bank and low overbank to a top elevation of 111.0.

b. The convex side (left bank) of the bend was excavated to el 96.0 to provide greater channel width and better curvature. These modifications provided a minimum channel width of 450 ft at each end of the bend and a maximum channel width of 650 ft near the center of the bend.

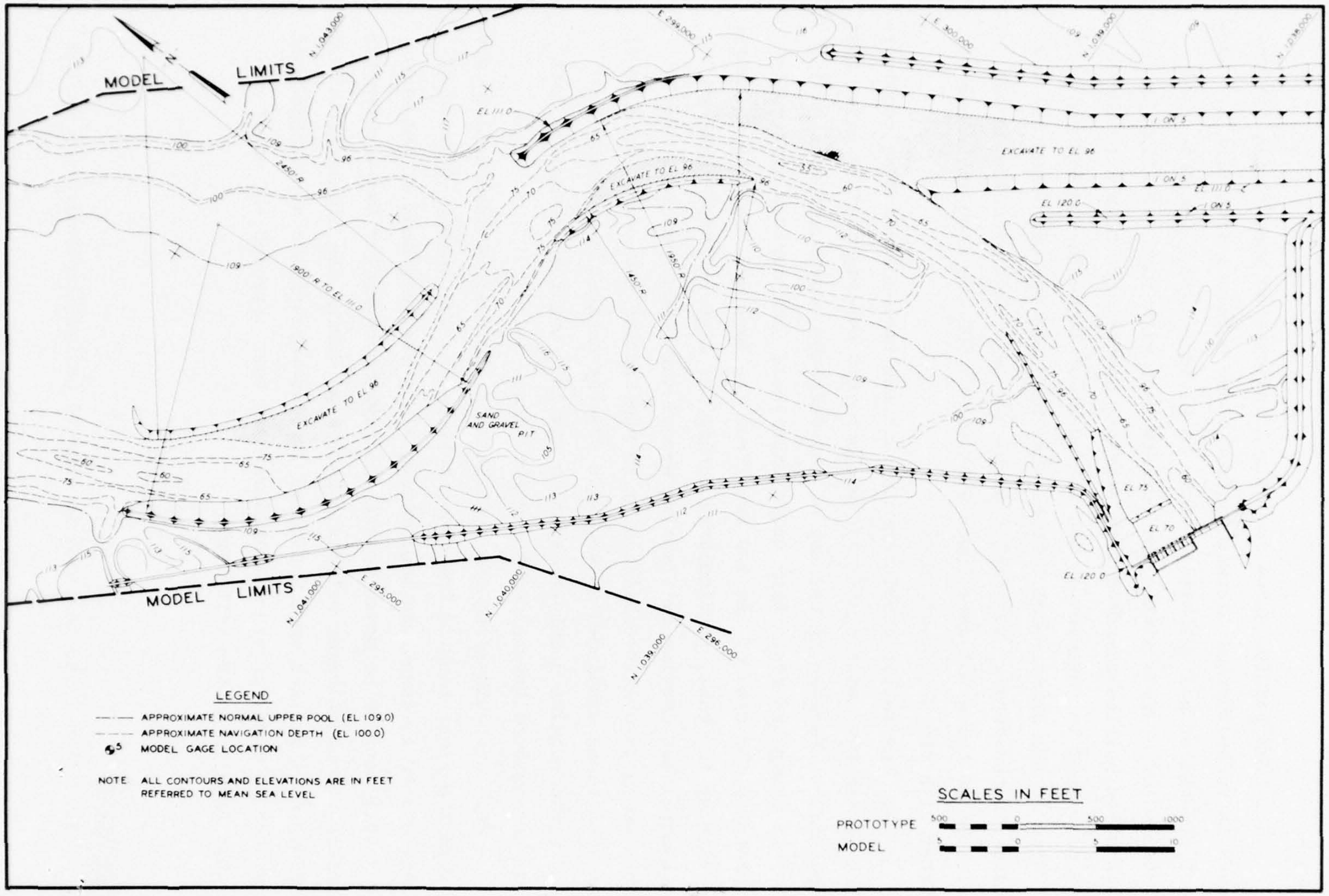


Figure 7. Plan B

Results

28. The results shown in Table 3 indicate no appreciable differences in water-surface elevations from those obtained with plan A. Current directions and velocities shown in Plates 6 and 7 indicate good distribution of flow within the revised bend with some reduction in the highest velocities compared with existing conditions (plan A). There was also some improvement in the alignment of currents and distribution of flow in the short reach between that bend and the bend near the entrance to the canal. Velocities along the left bank approaching the entrance to the canal were lower with the 64,500-cfs flow and somewhat higher with the 97,000-cfs flow.

29. Navigation conditions through the revised bend were considerably better than with plan A and would permit two-way traffic under most conditions. Because of the set of the currents, downbound tows moving closely along the right bank would experience considerable difficulty in keeping the head of the tow away from the bank and could be in danger of hitting the bank, particularly during the higher flows. However, downbound tows driving or flanking around the bend from along the left bank should have little difficulty in negotiating the bend. Because of the conditions mentioned above, safe two-way navigation through the bend would require downbound tows to navigate the bend along the left side and upbound tows along the right side.

30. Currents along the left bank of the revised bend tend to move toward the right bank in the reach between the two bends. Because of these currents, downbound tows moving along the left bank of the upper bend will tend to be moved toward the right bank making two-way traffic through the short reach extremely hazardous during the higher flows. No serious difficulties were indicated for two-way traffic approaching and leaving the canal provided that downbound tows approach the canal entrance from along the left bank.

Plan C

Description

31. Plan C was designed to improve navigation conditions in the

short reach between the two bends and reduce the hazard for tows passing in the reach. This plan was the same as plan B except for the following (Figure 8):

a. The excavation of the right bank in the bend just upstream of the entrance to the canal was modified on a shorter radius (1200 ft) for a distance of about 1200 ft with a 600-ft tangent on the upstream end. The bank was then shaped to a 1V on 3H slope to tie in with the fill along the concave side of the bend upstream.

b. The excavation of the left bank of the bend upstream was modified starting about 100 ft farther downstream than with plan B and excavating along a 2550-ft radius for about 2150 ft, with a 400-ft tangent tying into natural ground at the upstream end. The top of bank at each end of the excavation was filled to el 111.0; the fill was extended on the upstream end about 450 ft to high ground. This modification provided channel widths of about 375 ft near the upstream end of the bend, about 600 ft near the center, and about 450 ft near the downstream end.

Results

32. The results shown in Table 3 indicate no real change in water-surface elevations compared with those obtained with plan B. The total drop through the reach upstream of the dam (gages 1-7) was about 1.0 and 1.1 ft and through the dam (gages 7 and 8) about 0.6 and 0.7 ft for the 64,500- and 97,000-cfs flows, respectively.

33. Current direction and velocities shown in Plates 8 and 9 indicate a general improvement in the alignment of currents through the reach with little change in maximum velocities from those obtained during the test of plan B. In the upper bend, there was less tendency for currents moving along the left bank to cross toward the right bank in the reach between the two bends. The alignment and velocity of currents close along the left bank approaching the canal and across the entrance were improved considerably.

34. There was some improvement in navigation conditions over those obtained with plan B, but the improvement was not sufficient to provide safe two-way navigation through the entire reach during the higher flows. Two-way traffic could be maintained in the approach to the canal and in the bend upstream provided that downbound tows

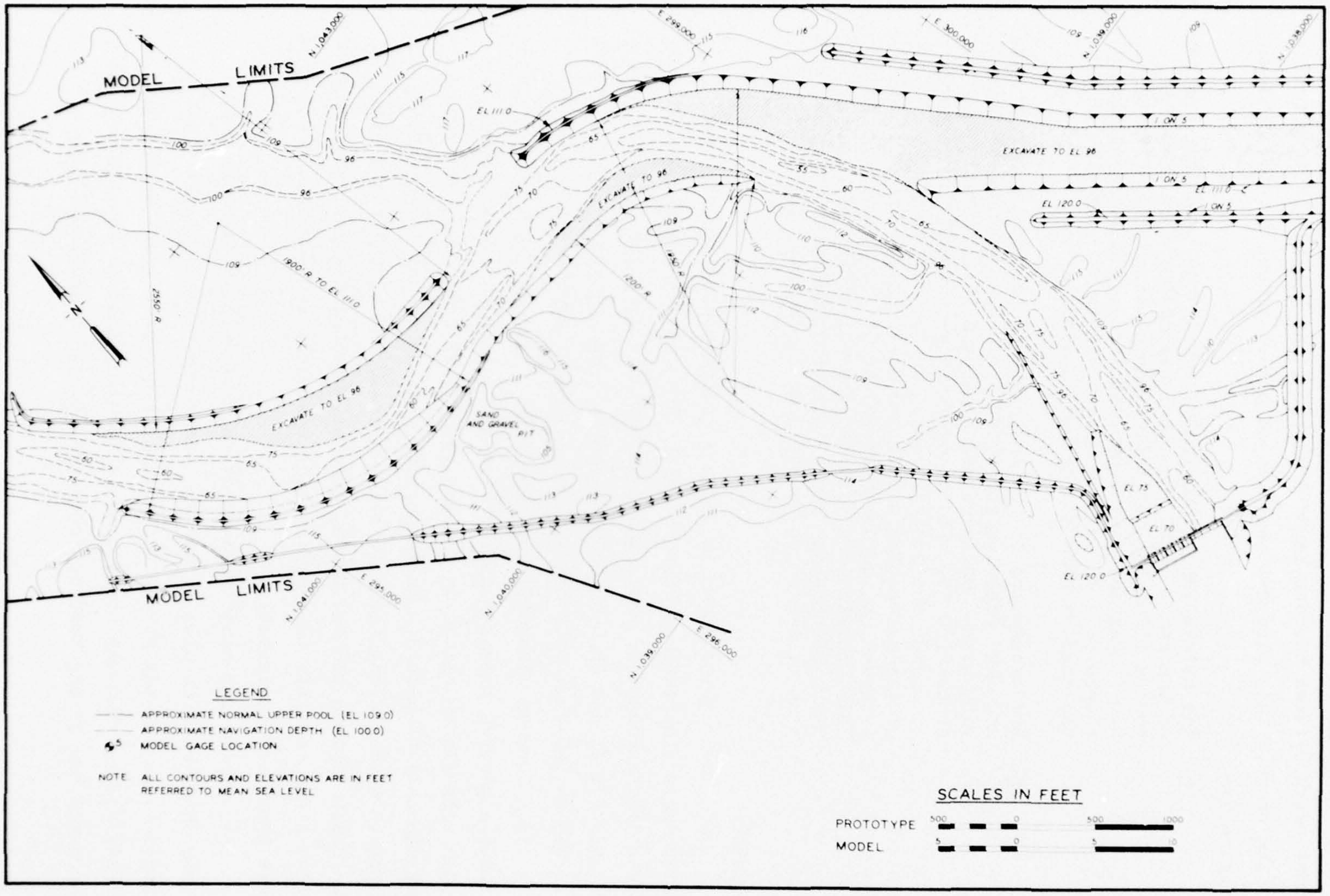


Figure 8. Plan C

approached the canal from along the left bank and upbound tows navigated along the right bank of the canal and in the bend. Navigation conditions in the reach between the two bends were affected by the limited channel width and by currents from the bend upstream making two-way navigation generally hazardous. Because of the set of the currents, navigation through the upper bend would also tend to be hazardous for two-way traffic during the higher flows.

Plan D

Description

35. Plan D was developed to improve navigation conditions in the upper bend with a reduction in the amount of excavation. This plan was the same as plan C except for the following (Figure 9):

- a. The radius of the earth-fill dike along the right bank in the upper bend was reduced from 1900 to 1545 ft extending upstream about 1350 ft from the sand and gravel pit, with a tangent from that point to about 850 ft upstream. The top of the fill was maintained at el 111.0.
- b. The right bank in the reach between the two bends was excavated on a straight line tangent to the curves formed by the right bank of both bends.
- c. The radius of the curve formed by excavation of the convex (left) bank of the upper bend was reduced from 2550 to 1075 ft, with tangents of 1500 and 700 ft on the upstream and downstream ends of the curve, respectively. The low bank along the upstream and downstream ends of the excavation was raised to el 111.0 with earth-fill dikes.

Results

36. The results shown in Table 4 indicate no change in water-surface elevations with the 64,500-cfs flow from those obtained with plan C. There was a lowering of about 0.1 ft in water level in the reach just upstream of the canal entrance with the 97,000-cfs flow. Water-surface elevations upstream of the canal entrance varied about 0.1 ft above or below those obtained with the original design (Table 1) depending on the gage locations with respect to the changes in the channel. The total drop in water-surface elevation upstream of the dam

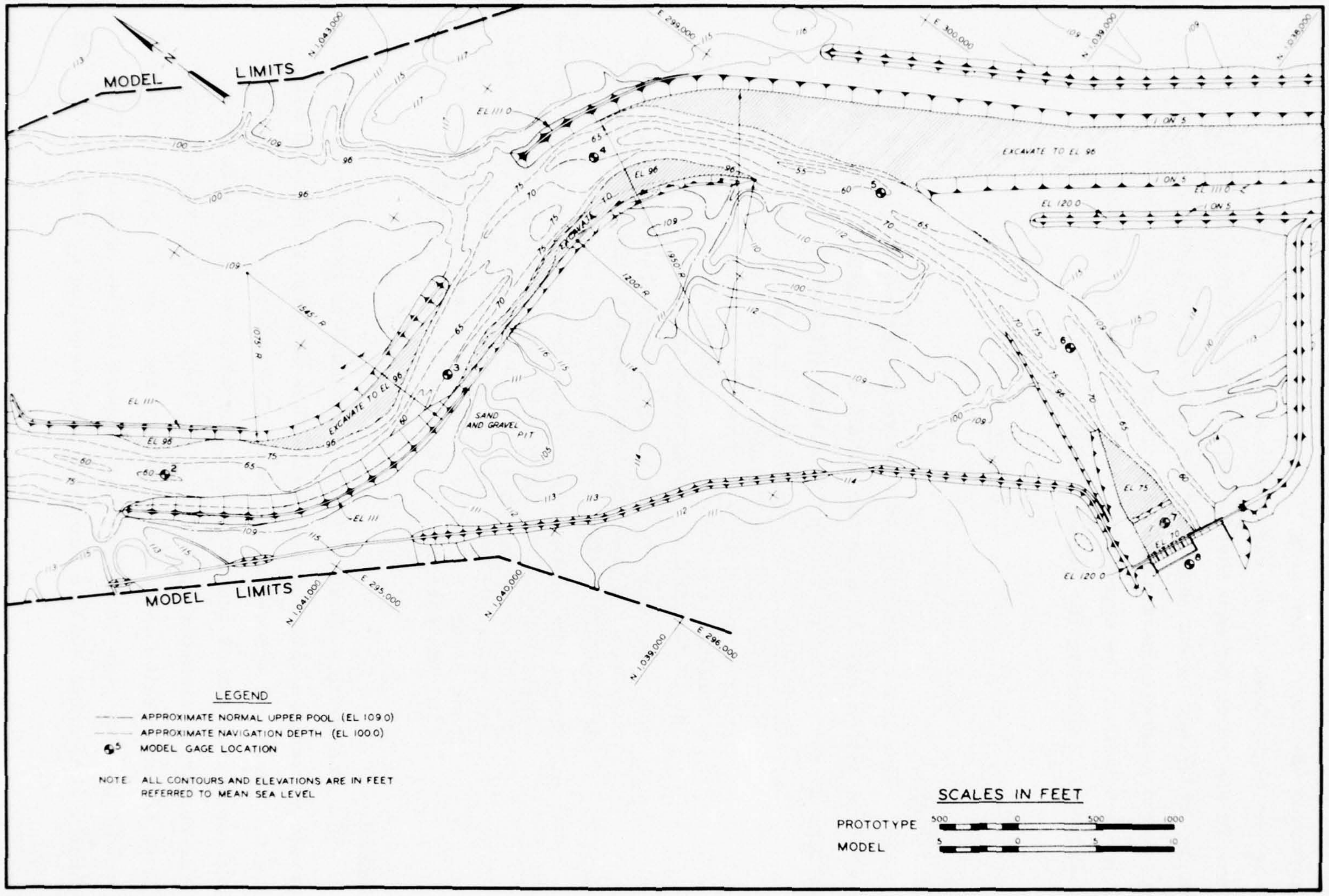


Figure 9. Plan D

(gages 1-7) was about 0.2 ft with the controlled flow and ranged from about 1.0 ft with the 64,000-cfs flow to about 1.2 ft with the 148,000-cfs flow. The drop through the dam (gages 7 and 8) was about 0.6 ft with the 64,000- and 148,000-cfs flows and about 0.7 ft with the 97,000-cfs flow.

37. Current directions and velocities shown in Plates 10-13 indicate some improvement in the alignment of currents and distribution of flow within the channel, particularly in the upper bend. Generally velocities in the upper bend were somewhat higher than with plan C because of the reduction in channel width. Maximum velocities in the bend just upstream of the entrance to the canal were lower than with plan C, but velocities along the left bank approaching the canal were somewhat higher. In the upper bend, maximum velocities ranged from about 6.6 to 7.4 fps and, in the bend just upstream of the canal entrance, from about 6.2 to 7.1 fps with the 64,500- and 97,000-cfs flows, respectively. With the 148,000-cfs flood flow, maximum velocities in the upper bend were slightly higher with little change in the lower bend. Current directions and velocities in the bend adjacent to the canal, in the lower end of the upper bend, and in the reach between bends were affected by flow over the left overbank causing the high-velocity currents to move toward and concentrate along the right bank.

38. Navigation conditions were better through the reach under study because of the improvement in the alignment of currents. Downbound tows could maintain steerage through the upper bend by driving, and two-way traffic could be continued through this reach without serious difficulties with flows up to 97,000-cfs discharge. It would be considerably easier for downbound tows to approach and enter the canal from along the left side of the river than from the center or right side since the high-velocity currents would be moving across the path of tows attempting to enter from the right side. Due to the high-velocity currents and the alignment of currents in this area, downbound tows approaching the entrance to the canal from the center to the right side of the channel would experience considerable difficulty in maintaining a satisfactory alignment and would endanger an upbound tow leaving the canal,

particularly during the higher flows. Two-way traffic could be maintained in the upper bend under most conditions. Downbound tows could navigate the upper bend with less difficulty and occupy less channel width by moving along the right bank of the bend. This would require downbound tows to cross from the right side of the channel to the left between the two bends to approach the canal from along the left bank. Crossing from one side of the channel to the other could cause some interference with two-way traffic at that point. Upbound traffic can navigate the reach from along either side of the channel.

Plan E

Description

39. Plan E was designed to reduce the amount of excavation in the upper bend without adversely affecting navigation conditions. This plan was the same as plan D except that the radius of the curve formed by the excavation on the left bank in the upper bend was increased from 1075 to 1124 ft, with the length of arc limited to about 1400 ft (Figure 10). An earth fill was placed along the top bank of the excavation to el 111.0. This plan provided a channel in the modified bend having a navigable width of about 430 ft near the upper end of the excavation to about 400 ft near the lower end.

Results

40. The results shown in Table 4 indicate little or no change in water-surface elevations from those obtained with plan D. The total drop in water-surface elevation upstream of the dam (gages 1-7) was about 1.1 ft with the 64,500-cfs flow and about 1.2 ft with the 97,000-cfs flow. The drop through the dam (gages 7 and 8) ranged from about 0.6 ft with the 64,500-cfs flow to about 0.7 ft with the 97,000-cfs flow.

41. Current directions and velocities shown in Plates 14-16 indicate little difference in maximum velocities through the reach from those obtained with plan D. Currents were generally parallel to the bank lines except near the lower end of the upper bend where currents tend to move from the left to the right side of the channel. Velocities

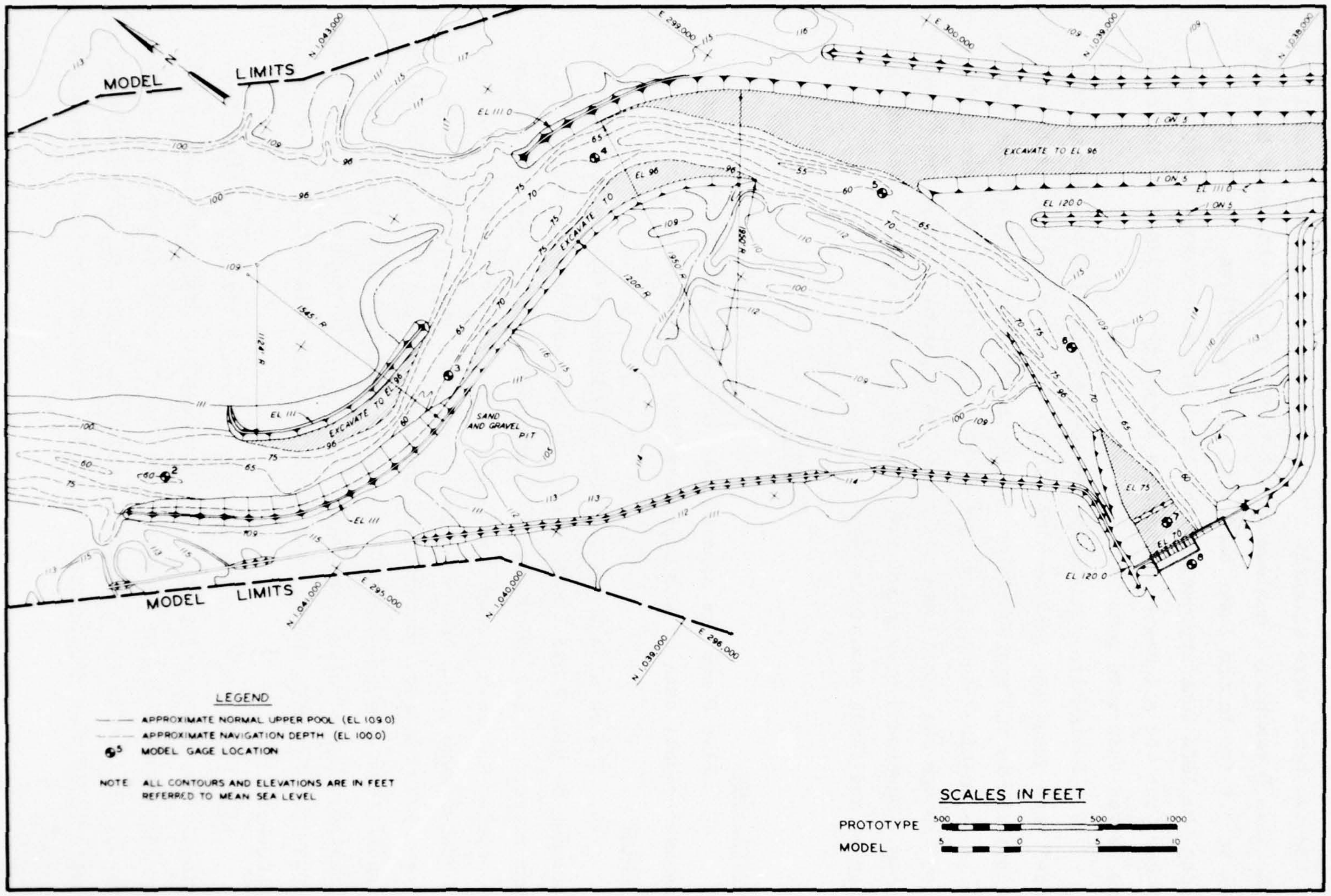


Figure 10. Plan E

in the two bends were slightly higher in some parts of the channel than with plan D reaching a maximum of 7.1 to 7.6 fps in the upper bend and 7.1 to 7.3 fps in the lower bend with open riverflows. Velocities along the left bank approaching the canal entrance also were somewhat higher, but the alignment of currents across the entrance to the canal was better than with plan D.

42. Navigation conditions for tows approaching or leaving the canal were about the same as with plan D. Two-way traffic could be maintained in the reach between the two bends, but considerable caution would be required in passing during the higher flows. Two-way navigation through the upper bend could also be hazardous during the higher flows. Downbound tows would have to move along the right side of the channel and flank around the bend.

Plan F

Description

43. Plan F was the same as plan E except that the fill along the concave (right) bank of the upper bend was eliminated (Figure 11).

Results

44. The results shown in Table 5 indicate that the modification included in plan F had little effect on water-surface elevations. Current directions and velocities indicate some reduction in the maximum velocities in the upper bend with a somewhat greater tendency for flows to concentrate along the right bank near the lower end of the bend (Plate 17). An eddy formed along the right bank of the bend during the higher flows, but the size of the eddy was smaller than that obtained with the original plan. Maximum velocities in the upper bend were about 6.8 to 6.9 fps with the uncontrolled flows and less than 3 fps with the 30,000-cfs flow.

45. Navigation conditions were generally similar to those obtained with plan E except that the tendency for downbound tows to hit the right bank near the downstream end of the bend was somewhat greater. Two-way traffic in the bend would tend to be hazardous during most flows particularly when passing near the lower reach of the bend. Conditions

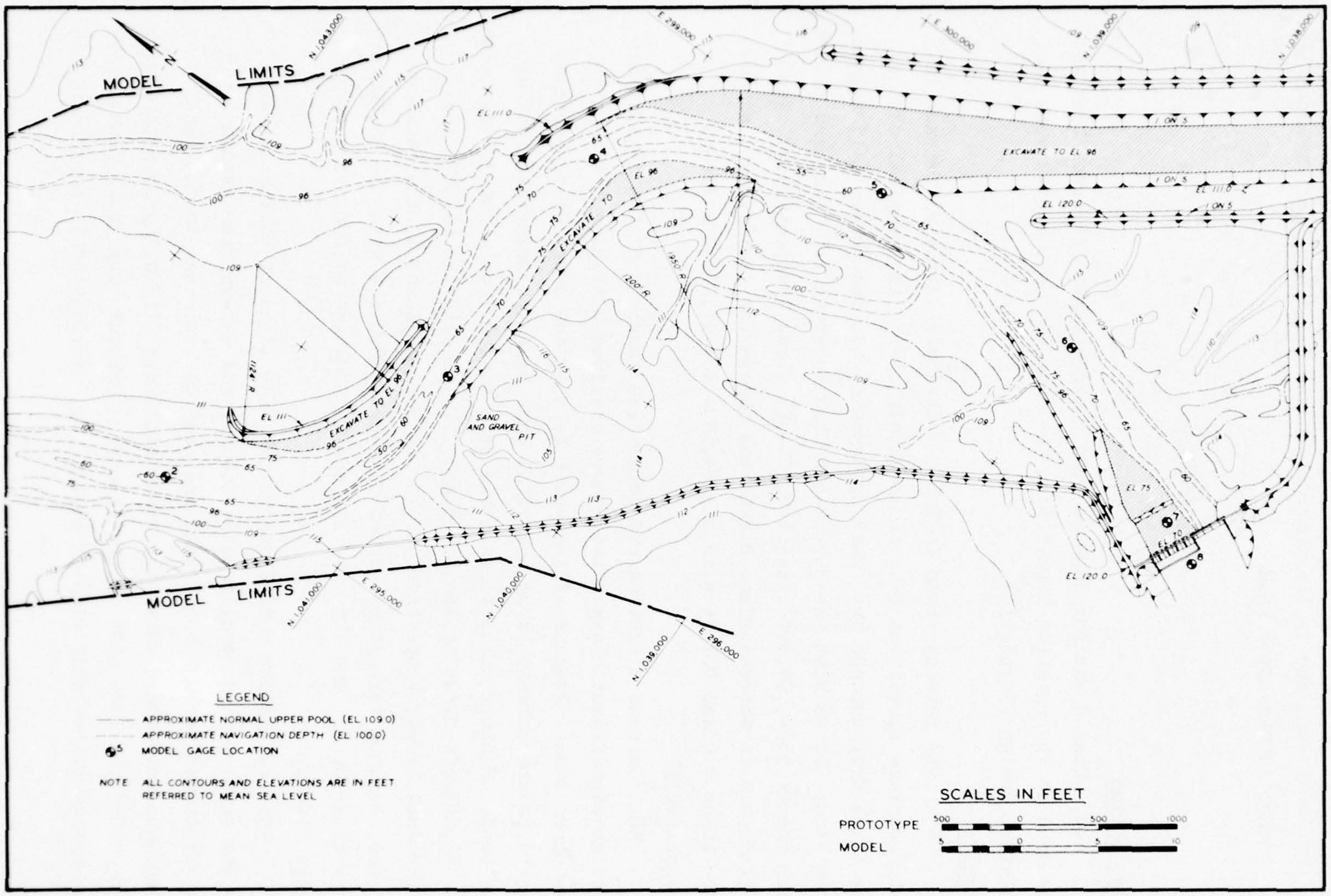


Figure 11. Plan F

in the lower bend and in the approach to the canal were not affected by the change in the upper bend.

Plan G

Description

46. Plan G was the same as plan F except that the upper bend was restored to its existing conditions, the same as those tested with the original design (Figure 12).

Results

47. The results shown in Table 5 indicate little difference in water-surface elevations from those obtained with the original design. The total drop through the reach upstream of the dam (gages 1-7) ranged from about 0.2 ft with the 30,000-cfs flow to about 1.0, 1.1, and 1.2 ft with the 64,500-, 97,000-, and 148,000-cfs flows, respectively. The differences in water-surface elevations across the dam (gages 7 and 8) were about 0.6 and 0.7 ft with the 64,500- and 97,000-cfs flows, respectively.

48. Current direction and velocities shown in Plates 18-20 indicate no significant changes from those obtained with plan F except in the upper bend. Because of the sharp turn in the upper bend, currents tended to concentrate along the right bank near the downstream end of the bend. Maximum velocities in the bend varied from about 3.1 fps with the 30,000-cfs flows to about 6.8 and 7.1 fps with the 64,500- and 97,000-cfs flows, respectively. In the bend adjacent to the canal entrance, maximum velocities varied from about 2.8 fps with the 30,000-cfs flow to about 6.0 and 7.0 fps with the 64,500- and 97,000-cfs flows, respectively.

49. Navigation conditions in the bend adjacent to the entrance to the canal were generally satisfactory, and two-way navigation could be maintained through this reach and near the entrance to the canal. Downbound tows could enter the canal with less difficulty by approaching from along the left side of the channel. Upbound tows could leave the canal from either side without difficulty. Navigation in the upper bend

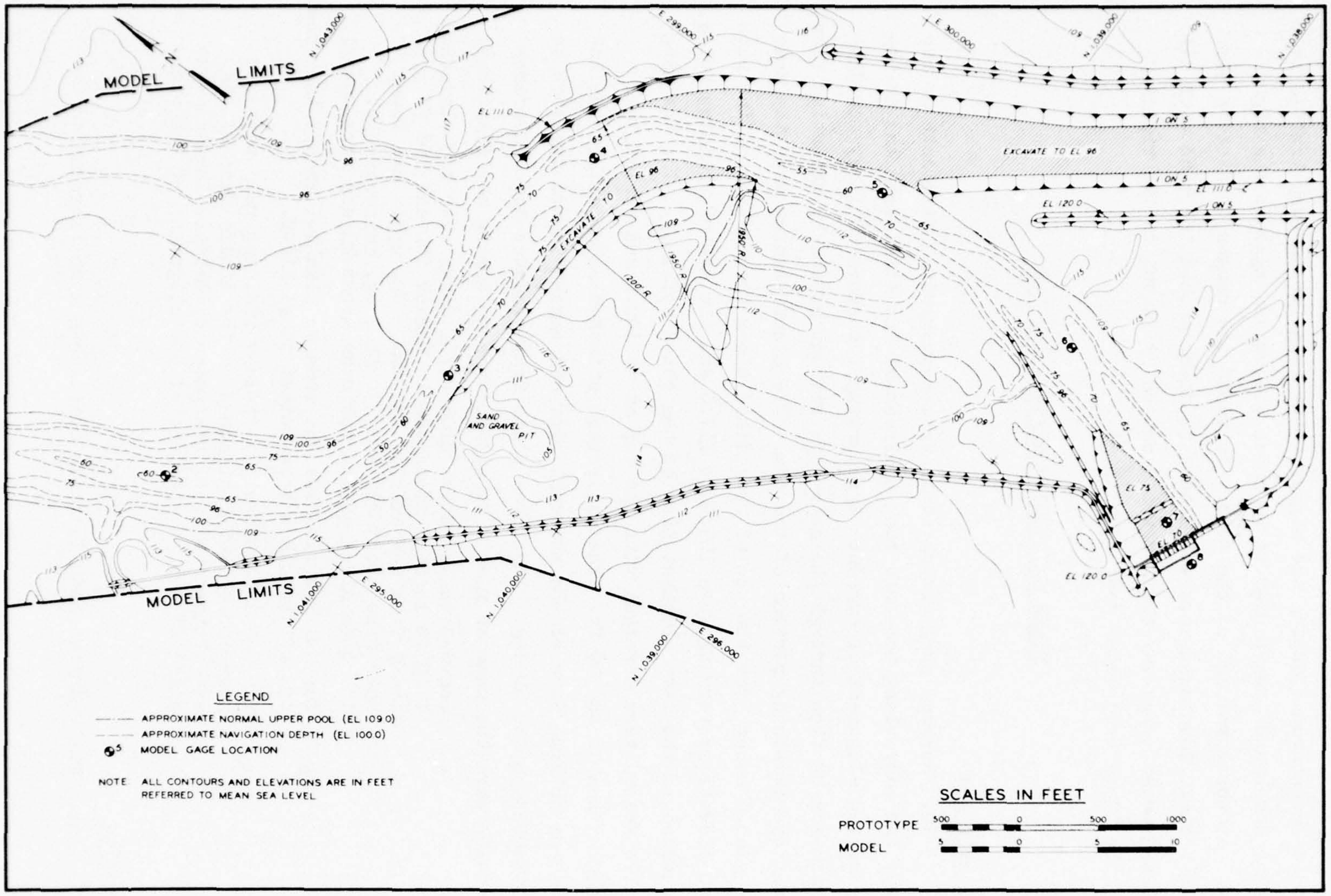


Figure 12. Plan G

could be hazardous during the higher flows even for one-way traffic because downbound tows tended to be moved toward and against the right bank at the lower end of the bend. To avoid the danger of hitting the right bank, downbound tows would have to flank around the bend with all flows tested. Two-way traffic would not be practical in the vicinity of the upper bend under most conditions.

Plans G-1, G-1 Modified, and G-2

Description

50. Several preliminary tests were conducted to eliminate or reduce the eddy along the left bank upstream of the fixed weir and to improve the alignment of currents approaching the gated spillway and distribution of flow through the gate bays without adversely affecting flow over the remaining portion of the dam. The plans studied were the same as plan G except for the use of rock dikes along the left bank line with top elevations varying from 105.0 to 117.0 and the use of training walls attached to the left abutment pier of the gated spillway. The training walls tested were straight with the top at el 100.0 and varied in length from 50 to 150 ft. The walls were attached along either the inside or outside face of the abutment pier and angled toward the left in increments up to 30 deg. The three plans that produced some favorable results were the same as plan G except for the following modifications:

- a. Plan G-1 included two stone-fill dikes with top elevation of 105.0 located along the left bank 300 and 700 ft upstream from the axis of the dam. The upper and lower dikes were about 200 and 230 ft long, respectively, with both dikes angled upstream about 25 deg from normal.
- b. Plan G-1 Modified was the same as plan G-1 except that the tops of the dikes were raised to el 110.0.
- c. Plan G-2 included a 125-ft-long training wall with top elevation of 100.0 attached to the inside face of the left abutment pier of the gated spillway. The wall was angled 25 deg to the left of the alignment of the pier.

Results

51. The results shown in Table 6 indicate some increase in the

proportion of the total flow through gate bay 5 (near left abutment) with the dikes of plans G-1 and G-1 Modified, but the change was too small to be significant. Raising the elevation of the rock dikes from 105.0 to 110.0 (plan G-1 Modified) was not as effective in improving the distribution of flow as the lower dikes of plan G-1. The rock dikes would tend to eliminate the eddy along the left bank just upstream of the fixed weir when overtopped. However, during the lower flows small eddies would form between the dikes and between the lower dike and the fixed weir. The dikes had no appreciable effect on the alignment of currents approaching the spillway (Plates 21 and 22). The best distribution of flow through the gated spillway was obtained with plan G-2. The percentage of the total flow through gate 5 was increased from 15.5 to 18.0 with the 64,500-cfs flow and from 14.0 to 17.0 with the 97,000-cfs flow (Table 6).

PART IV: DISCUSSION OF RESULTS AND CONCLUSIONS

Limitation of Model Results

52. The analysis of the results of this investigation is based principally on a study of (a) the effects of various plans and modifications on water-surface elevations, current directions, and velocities, and (b) the effects of resulting currents on the behavior of the model towboat and tow. In evaluating test results, consideration should be given to the fact that small changes in direction of flow or in velocities are not necessarily changes produced by a modification in plan since several floats introduced at the same point may follow a different path and move at slightly different velocities because of pulsating currents and eddies. Current directions and velocities shown in the plates were obtained with floats submerged to a depth of a loaded barge (9 ft prototype) and are indicative of the currents that would affect the behavior of tows.

53. The small scale of the model made it difficult to reproduce accurately the hydraulic characteristics of the prototype structures or to measure water-surface elevations within an accuracy of ±0.1 ft prototype. Also, the model limits did not include all of the floodway areas covered by the higher flows. The model was of the fixed-bed type and was not designed to simulate the movement of sediment in the prototype; therefore, changes in channel configurations and slopes resulting from changes in the channel bed and banks that might be caused by the structures or changes in flow conditions could not be developed naturally.

Summary of Results and Conclusions

54. The following results and conclusions were developed during this investigation:

a. There were no significant differences in the water-surface elevations upstream of the dam with any of the plans tested. The maximum difference in water-surface elevations in the reach upstream of the dam was about 1.2 ft,

and the maximum swell head across the dam was about 0.7 ft, with the 148,000- and 97,000-cfs flows, respectively.

b. Distribution of flow through the gated spillway was reasonably good with the original design except for the bay on the left near the fixed-crest weir. Flow through the gated spillway was affected by the location of the spillway and the fixed weir with respect to the river channel.

c. Distribution of flow through the spillway could be improved with a training wall similar to that tested in plan G-2. The change in flow distribution with this plan would have only a small effect on water-surface elevations upstream, particularly during the higher flows.

d. Navigation conditions for downbound tows entering the navigation canal as originally planned would be extremely difficult and hazardous because of the high-velocity currents across the entrance and the need for tows to turn toward the canal leaving the stern exposed to the currents.

e. Because of the set of the currents, sharp turns, and limited channel widths, downbound tows would have serious difficulties in the bends upstream of the entrance with the existing condition (August 1971 survey).

f. Satisfactory navigation conditions could be provided near the entrance to the canal with modification of the entrance and the bend upstream as included in plan A or D. With these modifications, safe two-way traffic would be practical in this vicinity provided that downbound tows approach the canal from along the left bank and upbound tows leave the canal from along the right bank.

g. Under most conditions, two-way traffic could be maintained through the reach upstream of the entrance to the canal with the modification of plan D. Downbound tows could navigate the upper bend with less difficulty by moving along the right bank. This would require the downbound tow to cross toward the left bank for a satisfactory approach to the canal and the upbound tow to cross toward the left bank to negotiate the upper bend.

Table 1

Water-Surface Elevations, Original Design

Gage No.	Water-Surface Elevations, ft msl, at Indicated Discharges, cfs			
	30,000	64,500	97,000	148,000
1	109.2	110.0	116.1	120.5
2	109.2	109.8	115.8	120.1
3	109.1	109.6	115.6	120.0
4	109.1	109.5	115.5	119.9
5	109.0	109.3	115.1	119.6
6	109.0	109.1	115.1	119.4
7	109.0*	109.0	115.0	119.3
8	92.5*	108.4*	114.3*	118.7*

* Controlled elevations.

Table 2

Flow Distributions, Original Design

Gate Bay*	Percent of Total Riverflow at Indicated Discharges, cfs	
	64,500	97,000
1	21.0	18.0
2	21.0	17.0
3	21.0	18.0
4	21.0	19.0
5	15.5	14.0
Fixed weir	0.5	7.0
Overflow dike (right bank)	--	7.0

* Gate bays numbered from right to left.

Table 3

Water-Surface Elevations, Plans A, B, and C

Gage No.	Water-Surface Elevations, ft msl, at Indicated Discharges, cfs					
	Plan A		Plan B		Plan C	
	64,500	97,000	64,500	97,000	64,500	97,000
1	109.9	116.1	110.0	116.0	110.0	116.1
2	109.6	115.8	109.6	115.8	109.7	115.8
3	109.4	115.6	109.5	115.6	109.6	115.8
4	109.4	115.5	109.4	115.5	109.5	115.5
5	109.2	115.3	109.3	115.2	109.4	115.3
6	109.0	115.1	109.1	115.1	109.1	115.1
7	109.0	115.0	109.0	115.0	109.0	115.0
8	108.4*	114.3*	108.4*	114.3*	108.4*	114.3*

* Controlled elevations.

Table 4

Water-Surface Elevations, Plans D and E

Gage No.	Water-Surface Elevations, ft msl, at Indicated Discharges, cfs						
	Plan D				Plan E		
	30,000	64,500	97,000	148,000	30,000	64,500	97,000
1	109.2	110.0	116.1	120.5	109.2	110.0	116.1
2	109.2	109.7	115.8	120.1	109.2	109.8	115.8
3	109.1	109.6	115.7	120.0	109.2	109.6	115.6
4	109.1	109.5	115.4	119.9	109.1	109.4	115.4
5	109.0	109.4	115.2	119.6	109.0	109.3	115.3
6	109.0	109.1	115.1	119.4	109.0	109.0	115.1
7	109.0*	109.0	115.0	119.3	109.0*	109.0	115.0
8	92.5*	108.4*	114.3*	118.7*	92.5*	108.4*	114.3*

* Controlled elevations.

Table 5

Water-Surface Elevations, Plans F and G

Gage No.	Water-Surface Elevations, ft msl, at Indicated Discharges, cfs: Plan F, 30,000	Plan F, 64,500	Plan F, 97,000	Plan G, 30,000	Plan G, 64,500	Plan G, 97,000	Plan G, 148,000
1	109.2	110.0	116.2	109.2	110.0	116.1	120.5
2	109.2	109.7	115.8	109.2	109.8	115.8	120.1
3	109.2	109.6	115.6	109.1	109.6	115.6	120.0
4	109.1	109.5	115.4	109.1	109.5	115.5	119.9
5	109.0	109.3	115.1	109.0	109.3	115.1	119.6
6	109.0	109.1	115.1	109.0	109.1	115.1	119.4
7	109.0*	109.0	115.0	109.0*	109.0	115.0	119.3
8	92.5*	108.4*	114.3*	92.5*	108.4*	114.3*	118.7*

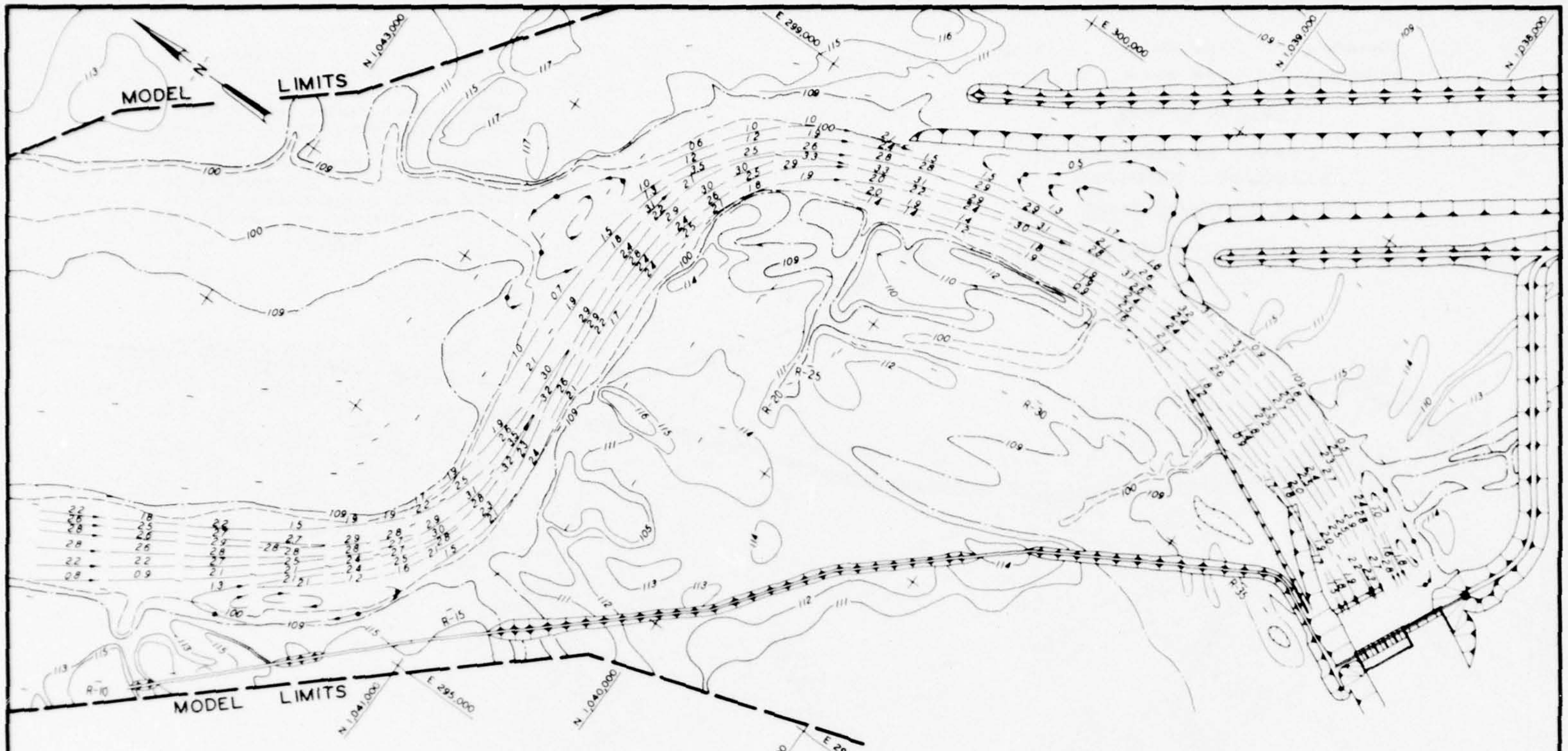
* Controlled elevations.

Table 6

Flow Distributions, Plans G, G-1, G-1 Modified, and G-2

Gate Bays*	Percent of Total Riverflow at Indicated Discharges, cfs							
	Plan G		Plan G-1		Plan G-1 Modified		Plan G-2	
	64,500	97,000	64,500	97,000	64,500	97,000	64,500	97,000
1	21.0	18.0	21.0	17.0	22.0	17.0	21.0	17.0
2	21.0	17.0	20.5	18.0	21.0	18.0	20.0	17.0
3	21.0	18.0	21.0	19.0	20.0	19.0	20.5	18.0
4	21.0	19.0	21.0	18.0	21.0	18.0	20.0	18.0
5	15.5	14.0	16.0	15.0	15.5	15.0	18.0	17.0
Fixed weir	0.5	7.0	0.5	6.0	0.5	6.0	0.5	6.0
Overflow dike (right bank)	--	7.0	--	7.0	--	7.0	--	7.0

* Gate bays numbered from right to left.



VELOCITIES AND CURRENT DIRECTIONS

ORIGINAL DESIGN

DISCHARGE 30,000 CFS
POOL EL 109.0 FT
TAILWATER EL 92.5 FT

SCALES IN FEET

PROTOTYPE 500 0 500 1000
MODEL 5 0 5 10

LEGEND

- 4.2 VELOCITY IN FEET PER SECOND
- VELOCITY LESS THAN 0.5 FEET PER SECOND
- APPROXIMATE NORMAL UPPER POOL (EL 109.0)
- APPROXIMATE NAVIGATION DEPTH (EL 100.0)

NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (9.0 FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO MEAN SEA LEVEL

PLATE 1

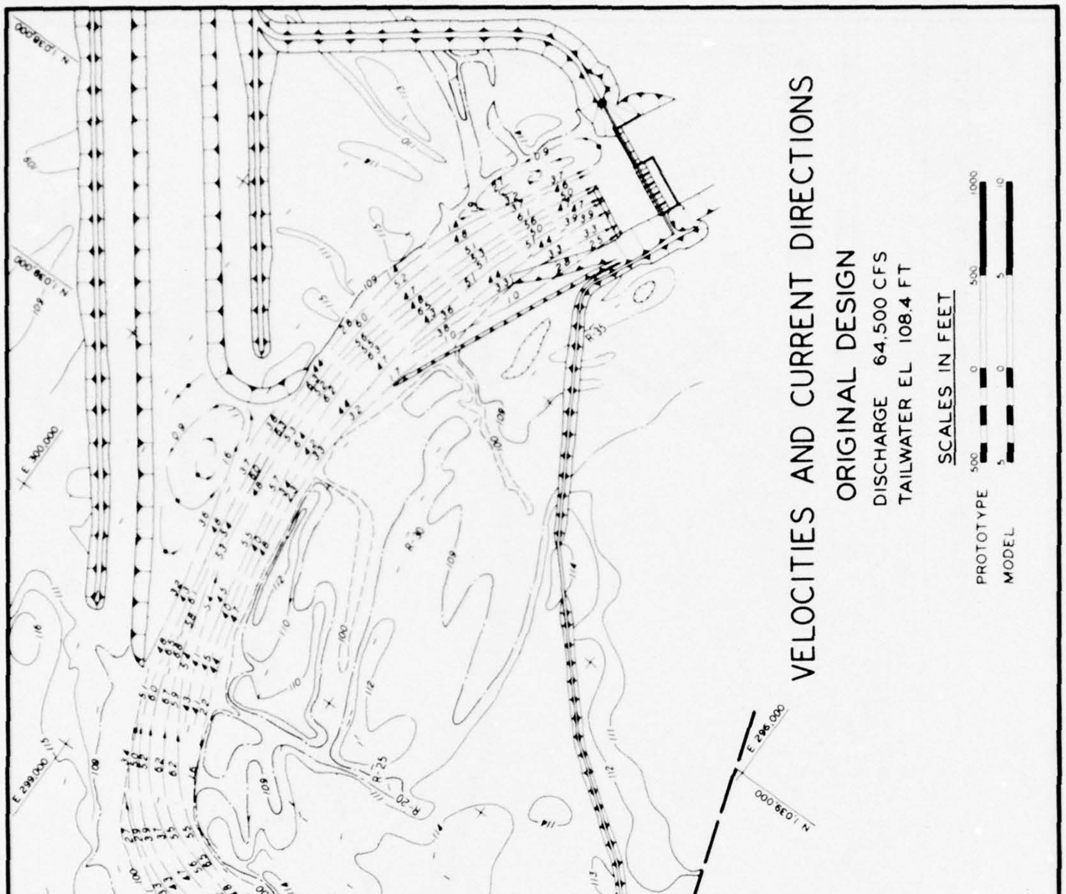
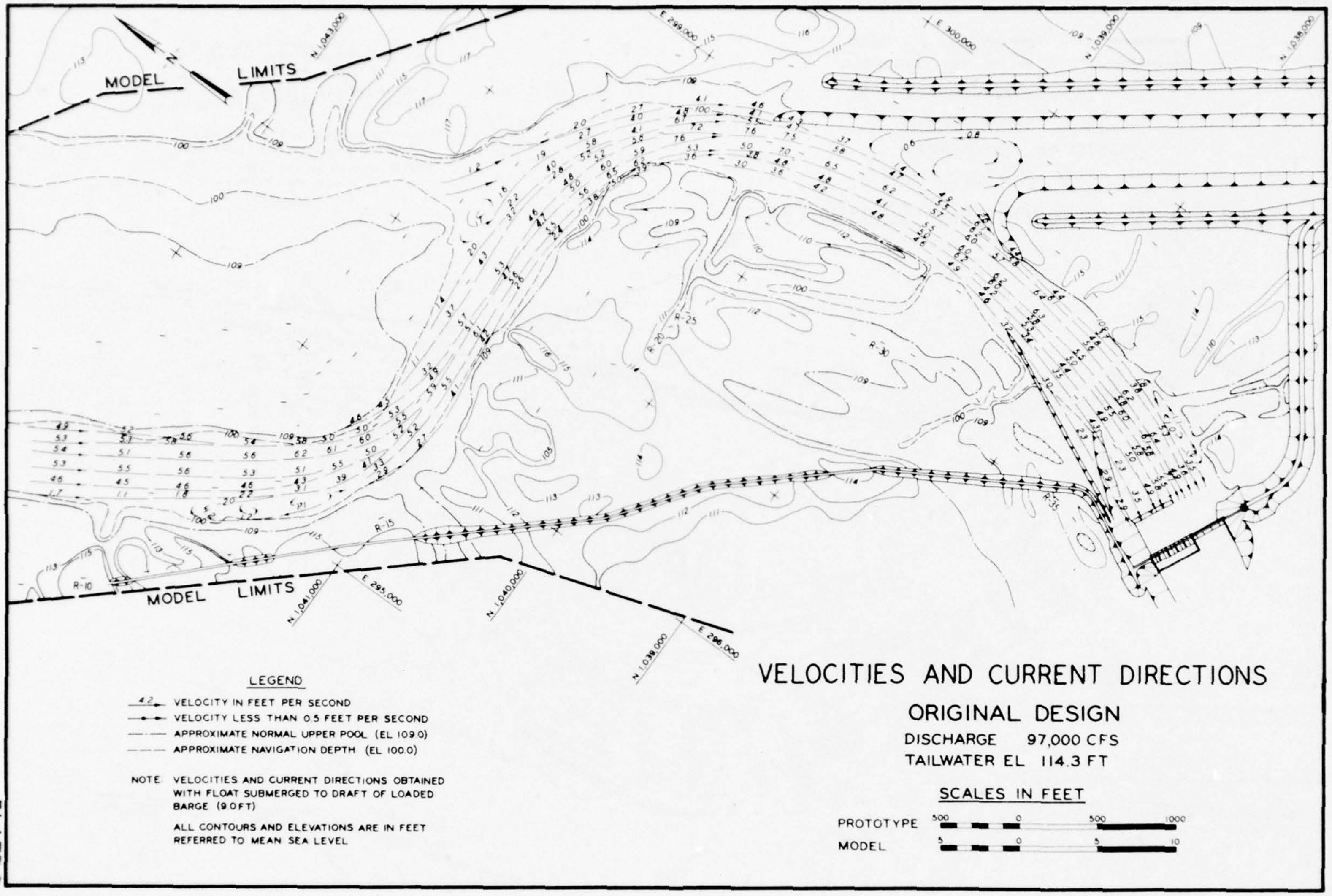

VELOCITIES AND CURRENT DIRECTIONS
ORIGINAL DESIGN
DISCHARGE 64,500 CFS
TAILWATER EL 108.4 FT
SCALES IN FEET
PROTOTYPE
MODEL
LEGEND
VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
APPROXIMATE NORMAL UPPER POOL (EL 109.0)
APPROXIMATE NAVIGATION DEPTH (EL 100.0)
NOTE VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (9.0 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO MEAN SEA LEVEL
MODEL LIMITS
MODEL LIMITS
E 295,000
E 296,000
E 299,000
E 300,000
N 1,038,000
N 1,039,000
N 1,040,000
N 1,041,000
N 1,043,000

PLATE 2


MODEL LIMITS
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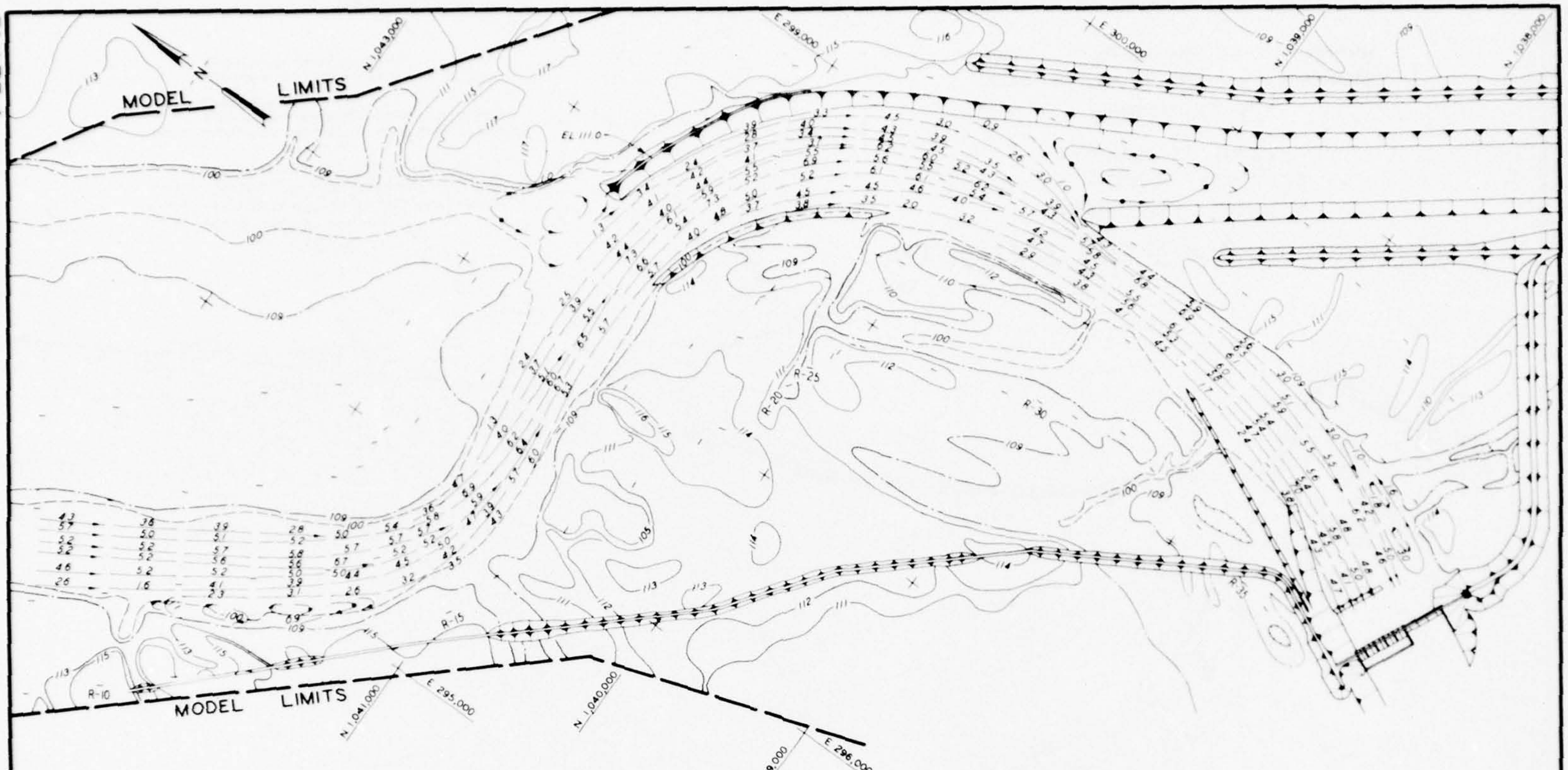
N 1,040,000
N 1,039,000
E 296,000
R-10
R-15
R-20
R-25
R-30
R-35
VELOCITIES AND CURRENT DIRECTIONS
ORIGINAL DESIGN
DISCHARGE 97,000 CFS
TAILWATER EL 114.3 FT
SCALES IN FEET
PROTOTYPE 500 0 500 1000
MODEL 5 0 5 10
LEGEND
4.2 VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
APPROXIMATE NORMAL UPPER POOL (EL 109.0)
APPROXIMATE NAVIGATION DEPTH (EL 100.0)
NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (9.0 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO MEAN SEA LEVEL

PLATE 3



VELOCITIES AND CURRENT DIRECTIONS

PLAN A

DISCHARGE 64,500 CFS
TAILWATER EL 108.4 FT

SCALES IN FEET

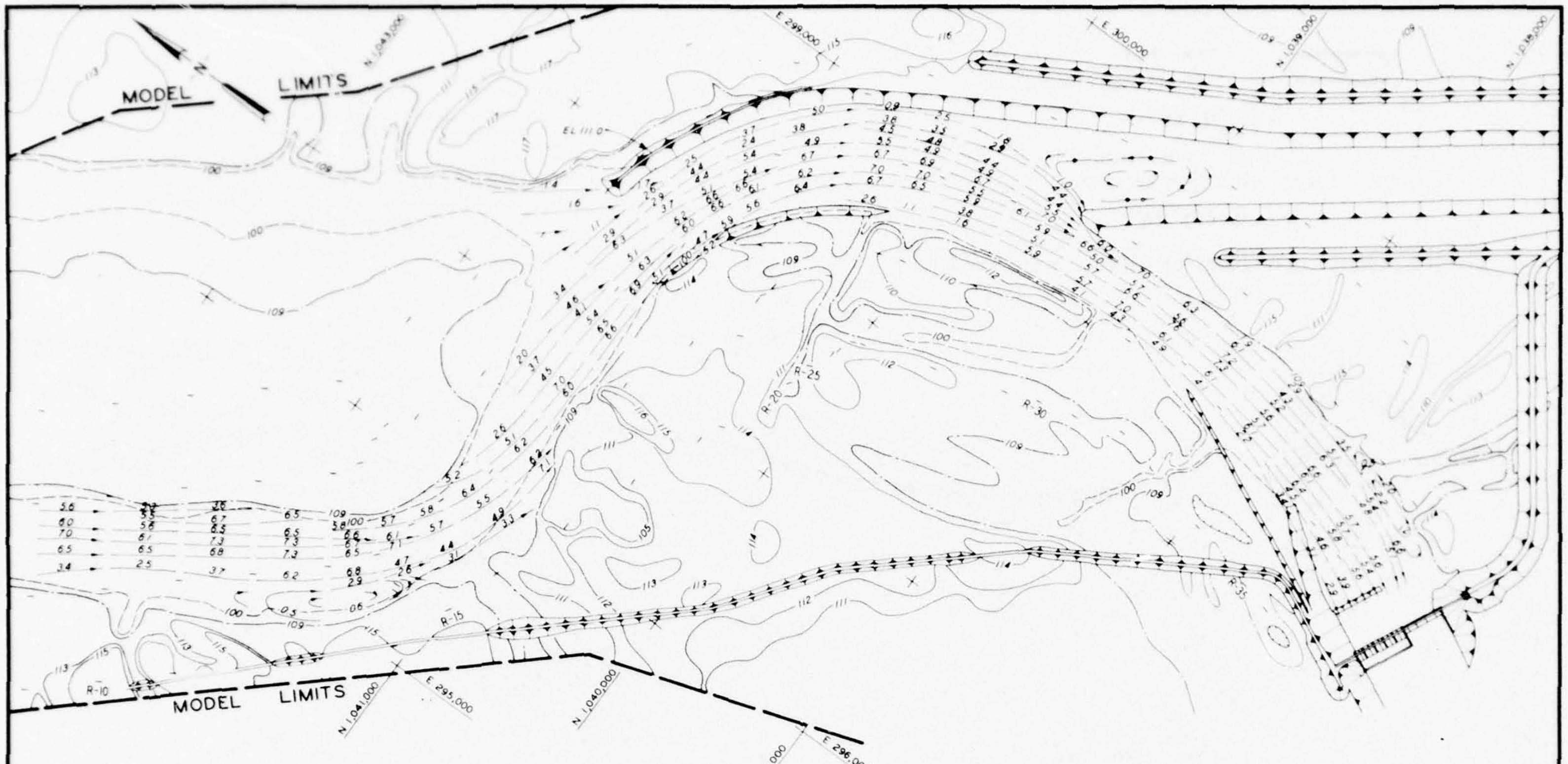
PROTOTYPE 500 0 500 1000
MODEL 5 0 5 10

LEGEND

- 4.2 VELOCITY IN FEET PER SECOND
- VELOCITY LESS THAN 0.5 FEET PER SECOND
- APPROXIMATE NORMAL UPPER POOL (EL 109.0)
- APPROXIMATE NAVIGATION DEPTH (EL 100.0)

NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (9.0 FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO MEAN SEA LEVEL



VELOCITIES AND CURRENT DIRECTIONS

PLAN A

DISCHARGE 97,000 CFS
TAILWATER EL 114.3 FT

LEGEND

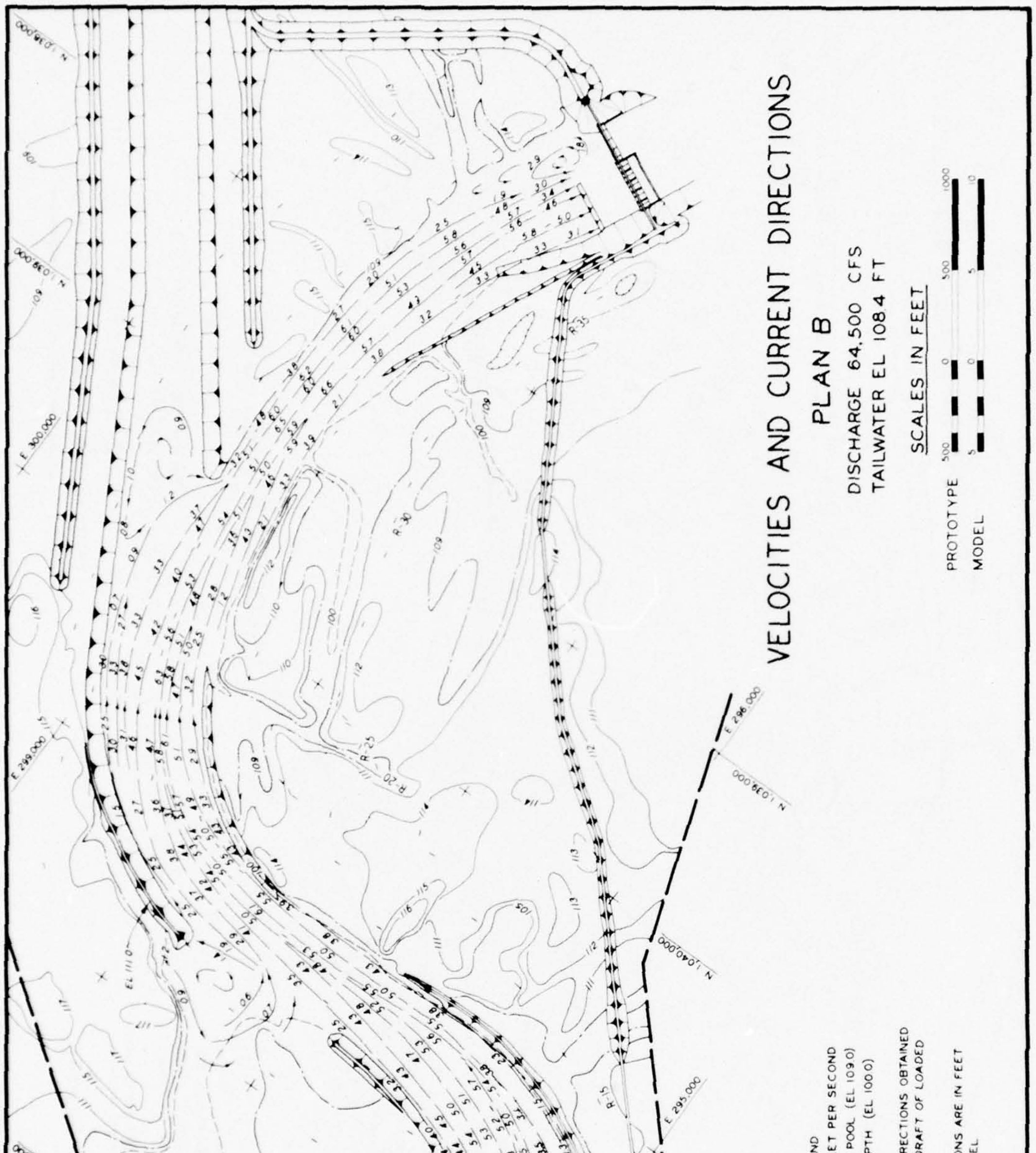
- 4.4 VELOCITY IN FEET PER SECOND
- VELOCITY LESS THAN 0.5 FEET PER SECOND
- APPROXIMATE NORMAL UPPER POOL (EL 109.0)
- APPROXIMATE NAVIGATION DEPTH (EL 100.0)

NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (9.0 FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO MEAN SEA LEVEL

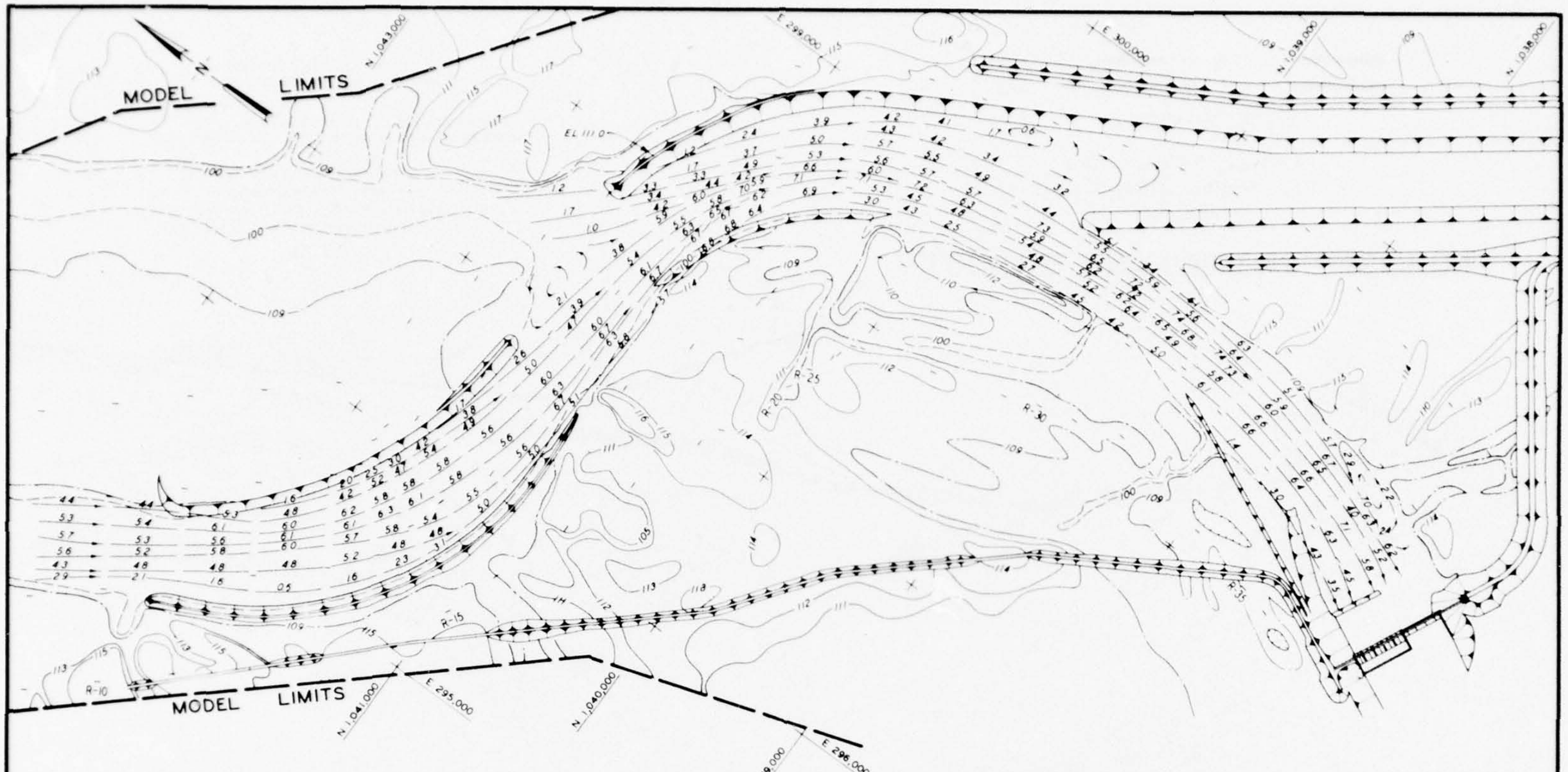
SCALES IN FEET

PROTOTYPE 500 0 500 1000
MODEL 5 0 5 10



VELOCITIES AND CURRENT DIRECTIONS
PLAN B
DISCHARGE 64,500 CFS
TAILWATER EL 1084 FT
SCALES IN FEET
PROTOTYPE 500 0 500 1000
MODEL 5 0 5 10
LEGEND
VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
APPROXIMATE NORMAL UPPER POOL (EL 1090)
APPROXIMATE NAVIGATION DEPTH (EL 1000)
NOTE VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (9.0 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO MEAN SEA LEVEL
MODEL LIMITS
MODEL LIMITS
N

PLATE 6



VELOCITIES AND CURRENT DIRECTIONS

PLAN B

DISCHARGE 97,000 CFS
TAILWATER EL 114.3 FT

LEGEND

- 4.2 VELOCITY IN FEET PER SECOND
- VELOCITY LESS THAN 0.5 FEET PER SECOND
- APPROXIMATE NORMAL UPPER POOL (EL 109.0)
- APPROXIMATE NAVIGATION DEPTH (EL 100.0)

NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (9.0 FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO MEAN SEA LEVEL

SCALES IN FEET

PROTOTYPE	500	0	500	1000
MODEL	5	0	5	10

VELOCITIES AND CURRENT DIRECTIONS

PLAN C

DISCHARGE 64,500 CFS
TAILWATER EL 108.4 FT

SCALES IN FEET

PROTOTYPE 500 0 500 1000
MODEL 5 0 5 10

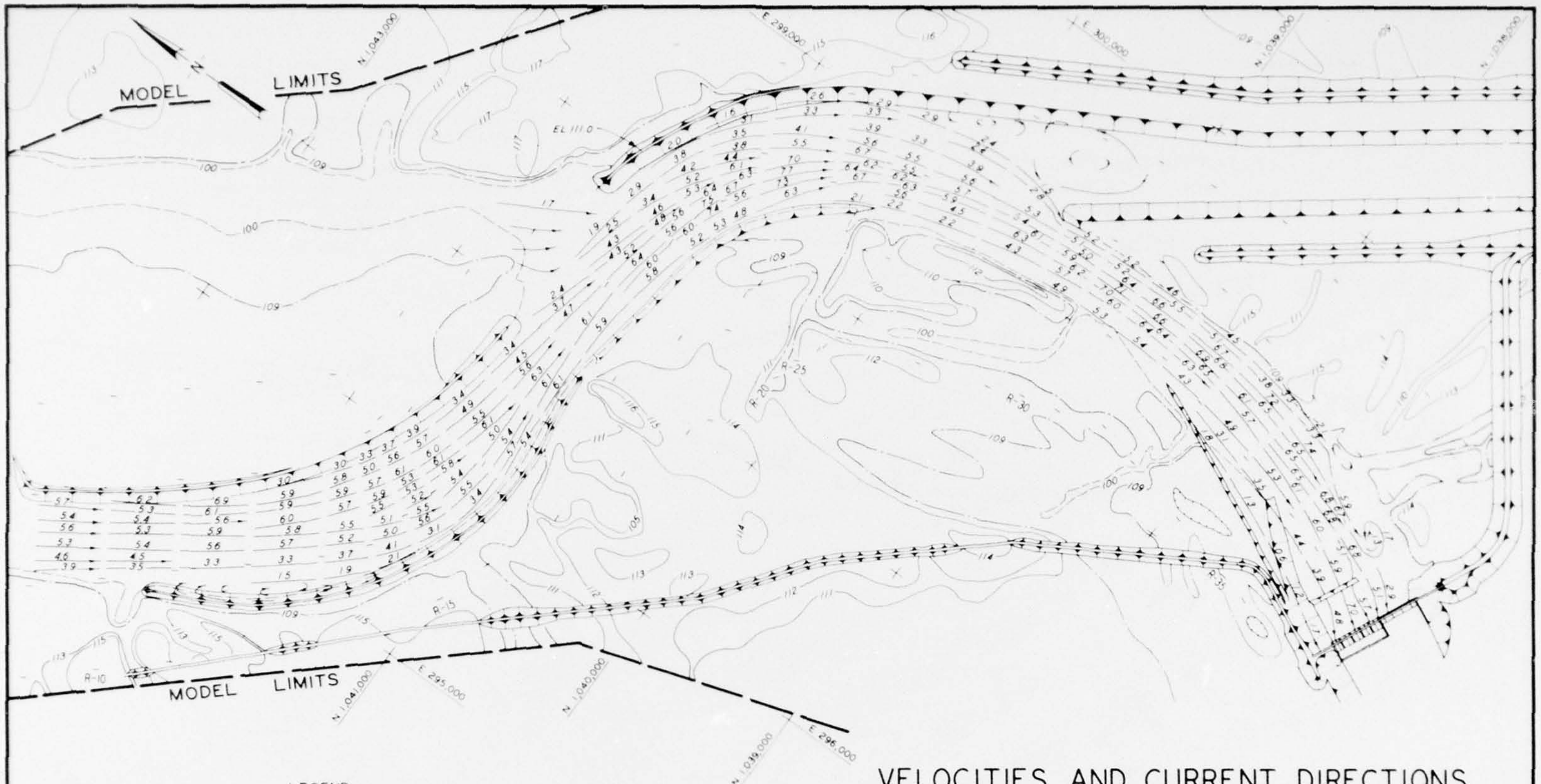
LEGEND

- 4.2 VELOCITY IN FEET PER SECOND
- VELOCITY LESS THAN 0.5 FEET PER SECOND
- APPROXIMATE NORMAL UPPER POOL (EL 109.0)
- APPROXIMATE NAVIGATION DEPTH (EL 100.0)

NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (9.0 FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO MEAN SEA LEVEL

PLATE 8



VELOCITIES AND CURRENT DIRECTIONS

PLAN C

DISCHARGE 97,000 CFS
TAILWATER EL 114.3 FT

LEGEND

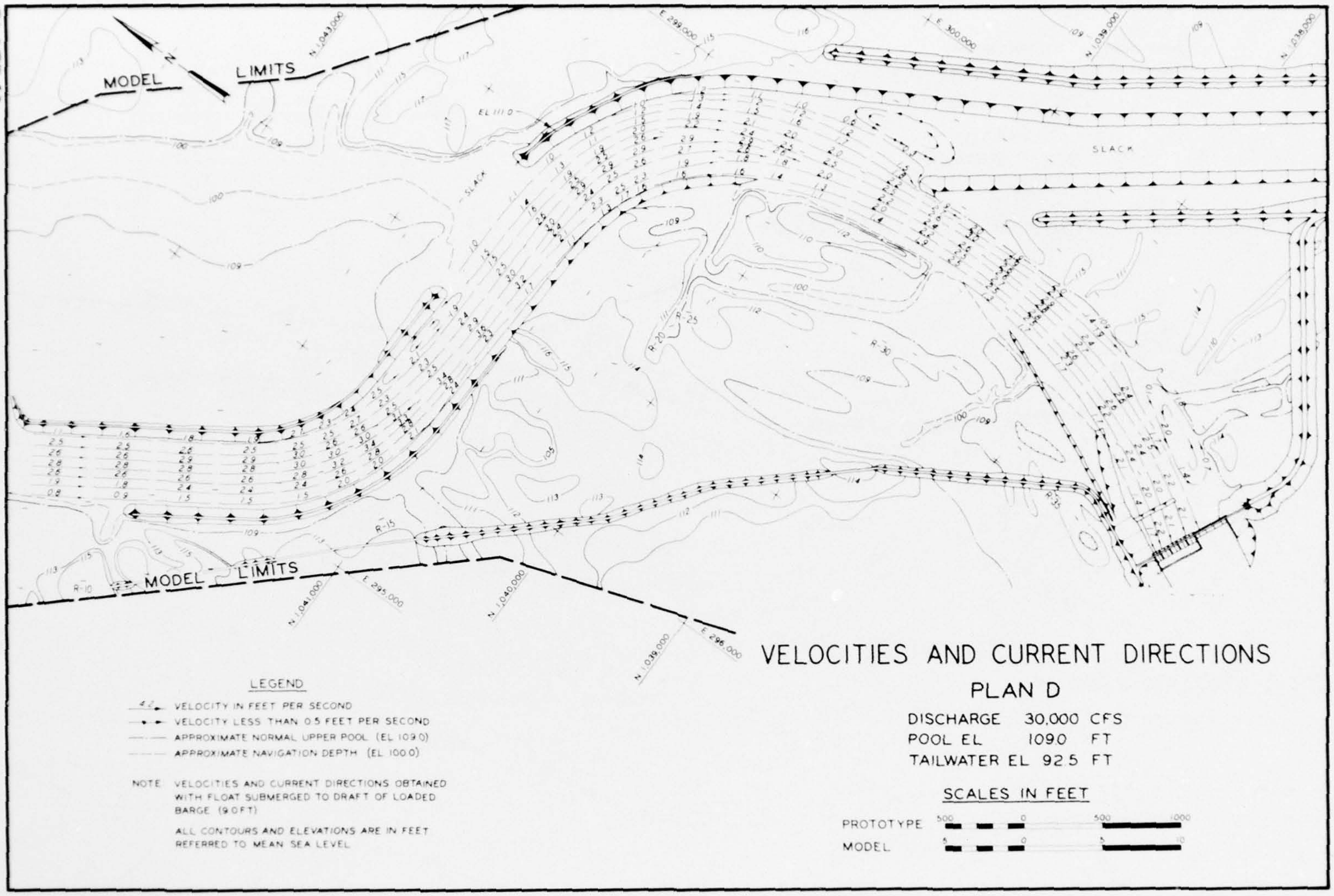
- 4.2 VELOCITY IN FEET PER SECOND
- VELOCITY LESS THAN 0.5 FEET PER SECOND
- APPROXIMATE NORMAL UPPER POOL (EL 109.0)
- APPROXIMATE NAVIGATION DEPTH (EL 100.0)

NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (9.0 FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO MEAN SEA LEVEL

SCALES IN FEET

PROTOTYPE	500	0	500	1000
MODEL	5	0	5	10

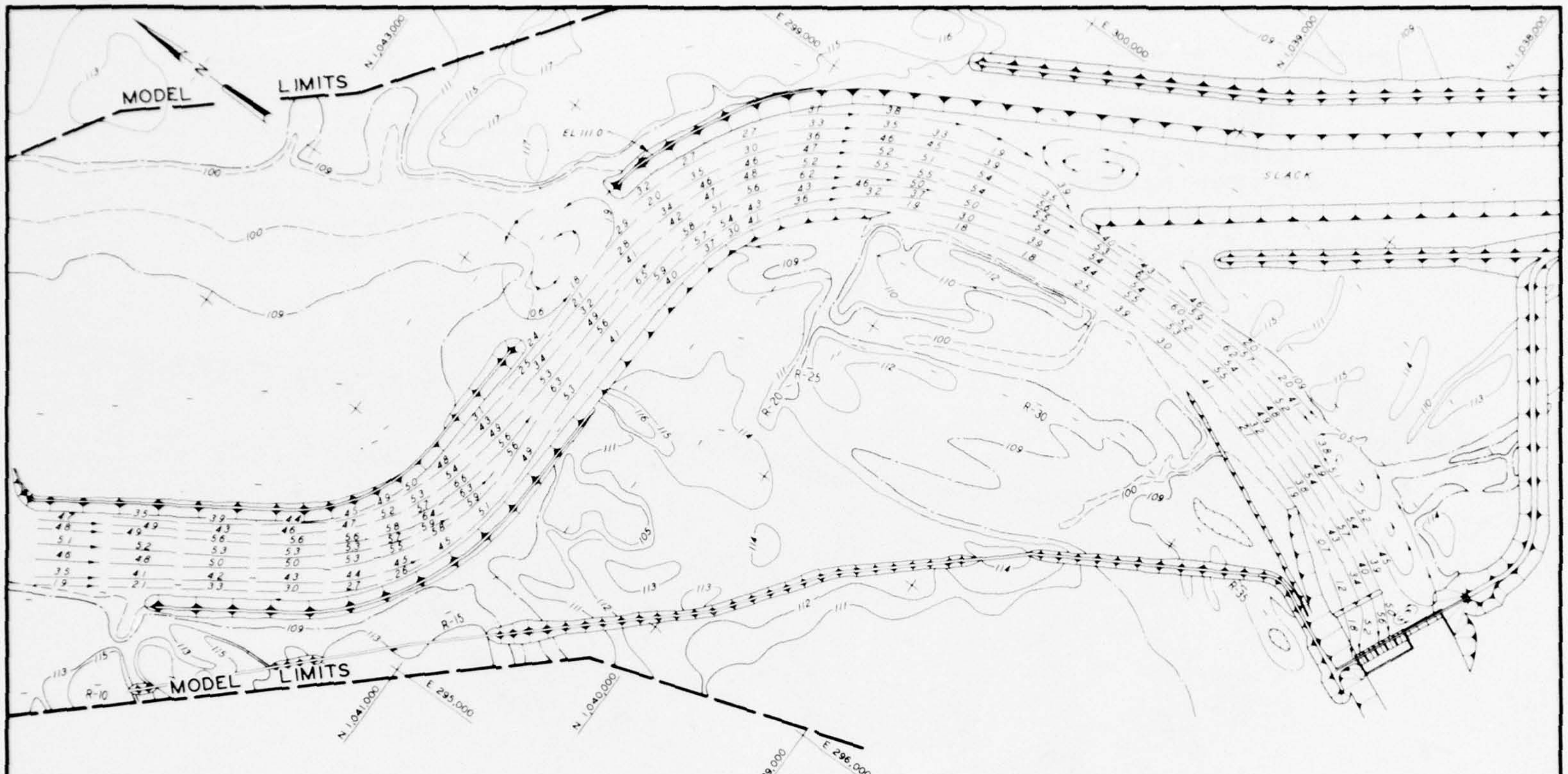


VELOCITIES AND CURRENT DIRECTIONS

PLAN D

DISCHARGE 30,000 CFS
POOL EL 109.0 FT
TAILWATER EL 92.5 FT

PLATE 10



VELOCITIES AND CURRENT DIRECTIONS

PLAN D

DISCHARGE 64,500 CFS
TAILWATER EL 108.4 FT

SCALES IN FEET

PROTOTYPE 500 0 500 1000
MODEL 5 0 5 10

LEGEND

- 4.2 VELOCITY IN FEET PER SECOND
- VELOCITY LESS THAN 0.5 FEET PER SECOND
- APPROXIMATE NORMAL UPPER POOL (EL 109.0)
- APPROXIMATE NAVIGATION DEPTH (EL 100.0)

NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (9.0 FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO MEAN SEA LEVEL

LEGEND

4.2 VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
APPROXIMATE NORMAL UPPER POOL (EL 109.0)
APPROXIMATE NAVIGATION DEPTH (EL 100.0)

NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (9.0 FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO MEAN SEA LEVEL

VELOCITIES AND CURRENT DIRECTIONS

PLAN D

DISCHARGE 97,000 CFS
TAILWATER EL 114.3 FT

SCALES IN FEET

PROTOTYPE 500 0 500 1000
MODEL 5 0 5 10

PLATE 12

VELOCITIES AND CURRENT DIRECTIONS

PLAN D

DISCHARGE 148,000 CFS
TAILWATER EL 118.7 FT

SCALES IN FEET

PROTOTYPE 500 0 500 1000
MODEL 5 0 5 10

LEGEND

- 4.2 VELOCITY IN FEET PER SECOND
- VELOCITY LESS THAN 0.5 FEET PER SECOND
- APPROXIMATE NORMAL UPPER POOL (EL 109.0)
- APPROXIMATE NAVIGATION DEPTH (EL 100.0)

NOTE VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (9.0 FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO MEAN SEA LEVEL

VELOCITIES AND CURRENT DIRECTIONS

PLAN E

DISCHARGE 30,000 CFS
TAILWATER EL 92.5 FT

LEGEND

- 4.2 VELOCITY IN FEET PER SECOND
- VELOCITY LESS THAN 0.5 FEET PER SECOND
- APPROXIMATE NORMAL UPPER POOL (EL 109.0)
- APPROXIMATE NAVIGATION DEPTH (EL 100.0)

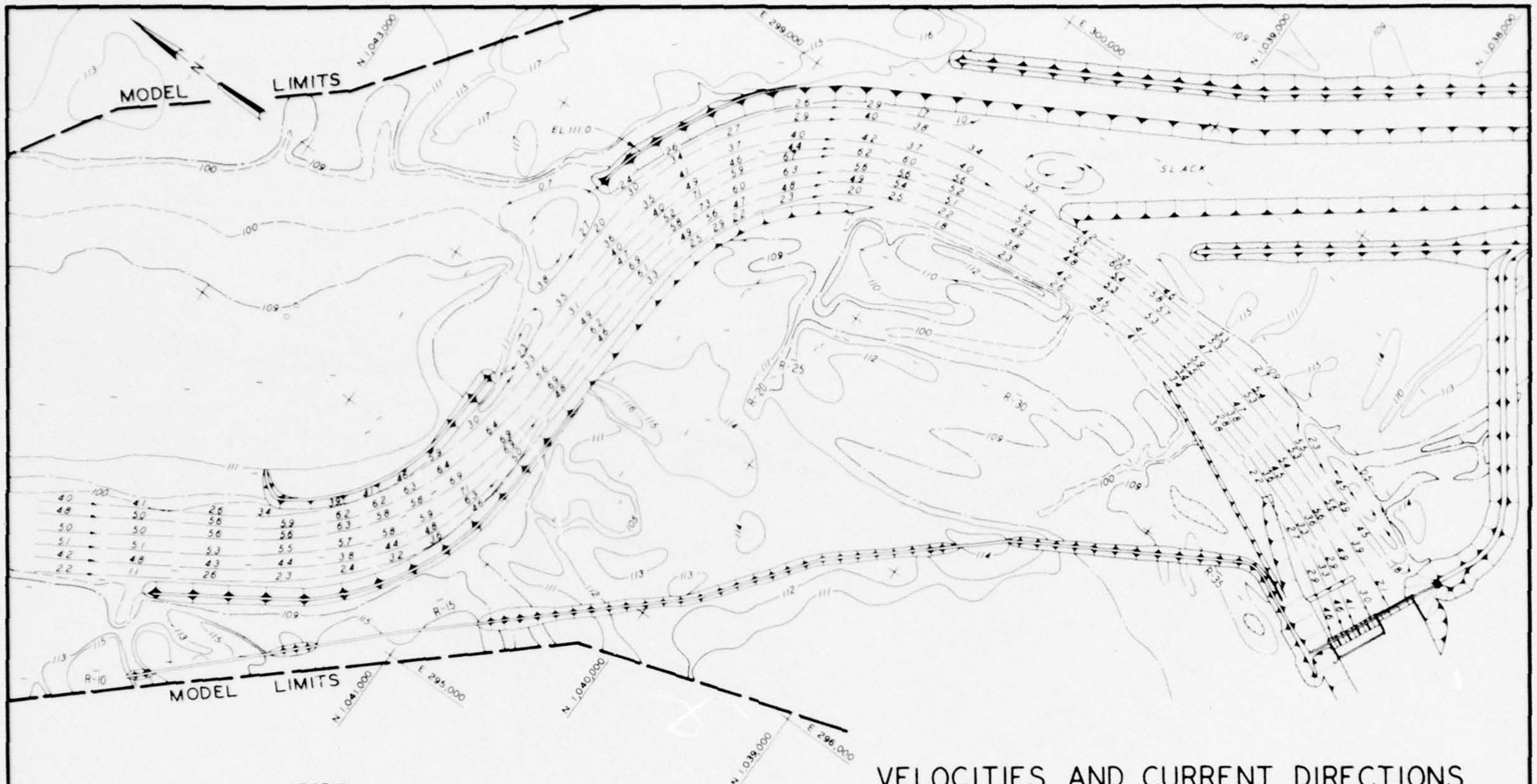
NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (9.0 FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO MEAN SEA LEVEL

SCALES IN FEET

PROTOTYPE 500 0 500 1000
MODEL 5 0 5 10

PLATE 14



VELOCITIES AND CURRENT DIRECTIONS

PLAN E

DISCHARGE 64,500 CFS

TAILWATER EL 108.4 FT

LEGEND

- 4.2 VELOCITY IN FEET PER SECOND
- VELOCITY LESS THAN 0.5 FEET PER SECOND
- APPROXIMATE NORMAL UPPER POOL (EL 109.0)
- APPROXIMATE NAVIGATION DEPTH (EL 100.0)

NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (9.0 FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO MEAN SEA LEVEL

SCALES IN FEET

PROTOTYPE 500 0 500 1000

MODEL 5 0 5 10

VELOCITIES AND CURRENT DIRECTIONS

PLAN E

DISCHARGE 97,000 CFS
TAILWATER EL 114.3 FT

LEGEND

- 4.2 VELOCITY IN FEET PER SECOND
- VELOCITY LESS THAN 0.5 FEET PER SECOND
- APPROXIMATE NORMAL UPPER POOL (EL 109.0)
- APPROXIMATE NAVIGATION DEPTH (EL 100.0)

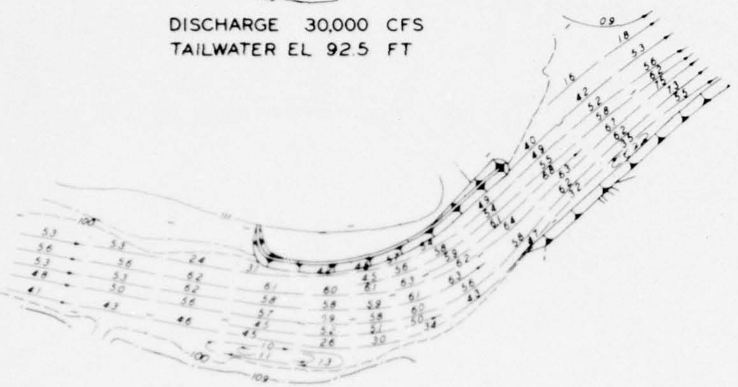
NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (9.0 FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO MEAN SEA LEVEL

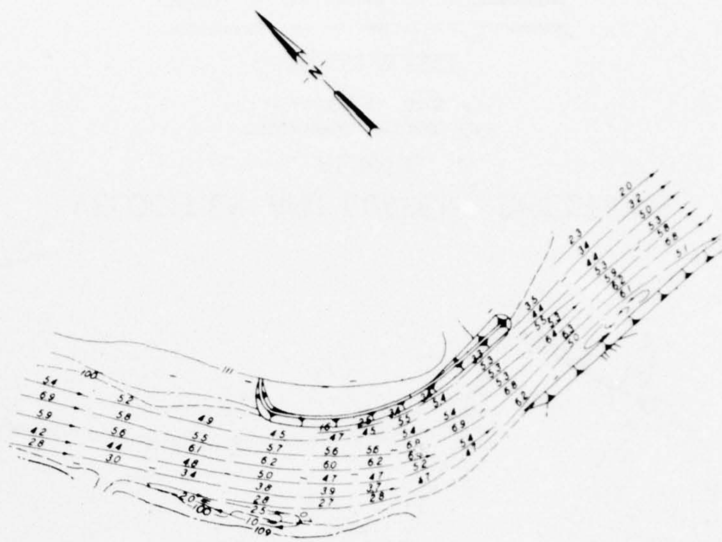
SCALES IN FEET

PROTOTYPE	500	0	500	1000
MODEL	5	0	5	10

DISCHARGE 30,000 CFS
TAILWATER EL 92.5 FT



DISCHARGE 97,000 CFS
TAILWATER EL 114.3 FT



DISCHARGE 64,500 CFS
TAILWATER EL 114.3 FT

LEGEND

- 4.2 — VELOCITY IN FEET PER SECOND
- VELOCITY LESS THAN 0.5 FEET PER SECOND
- APPROXIMATE NORMAL UPPER POOL (EL 109.0)
- APPROXIMATE NAVIGATION DEPTH (EL 100.0)

NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (9.0 FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO MEAN SEA LEVEL

VELOCITIES AND CURRENT DIRECTIONS

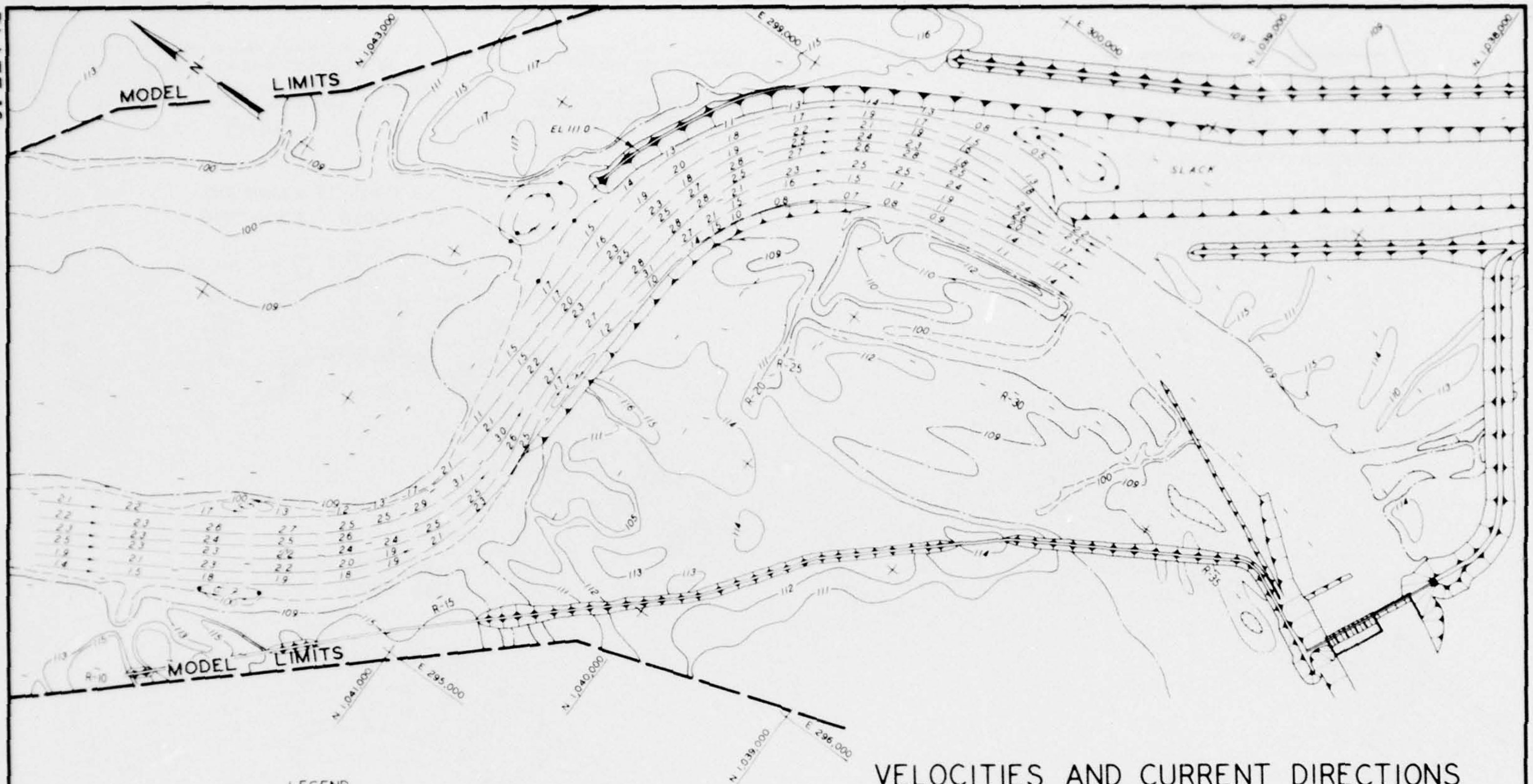
PLAN F

DISCHARGES 30,000, 64,500, AND 97,000 CFS

SCALES IN FEET

PROTOTYPE 500 0 500 1000

MODEL 5 0 5 10



VELOCITIES AND CURRENT DIRECTIONS

PLAN G

DISCHARGE 30,000 CFS
TAILWATER EL 92.5 FT

SCALES IN FEET

PROTOTYPE 500 0 500 1000
MODEL 5 0 5 10

LEGEND

- 4.2 VELOCITY IN FEET PER SECOND
- VELOCITY LESS THAN 0.5 FEET PER SECOND
- APPROXIMATE NORMAL UPPER POOL (EL 109.0)
- APPROXIMATE NAVIGATION DEPTH (EL 100.0)

NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (9.0 FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO MEAN SEA LEVEL

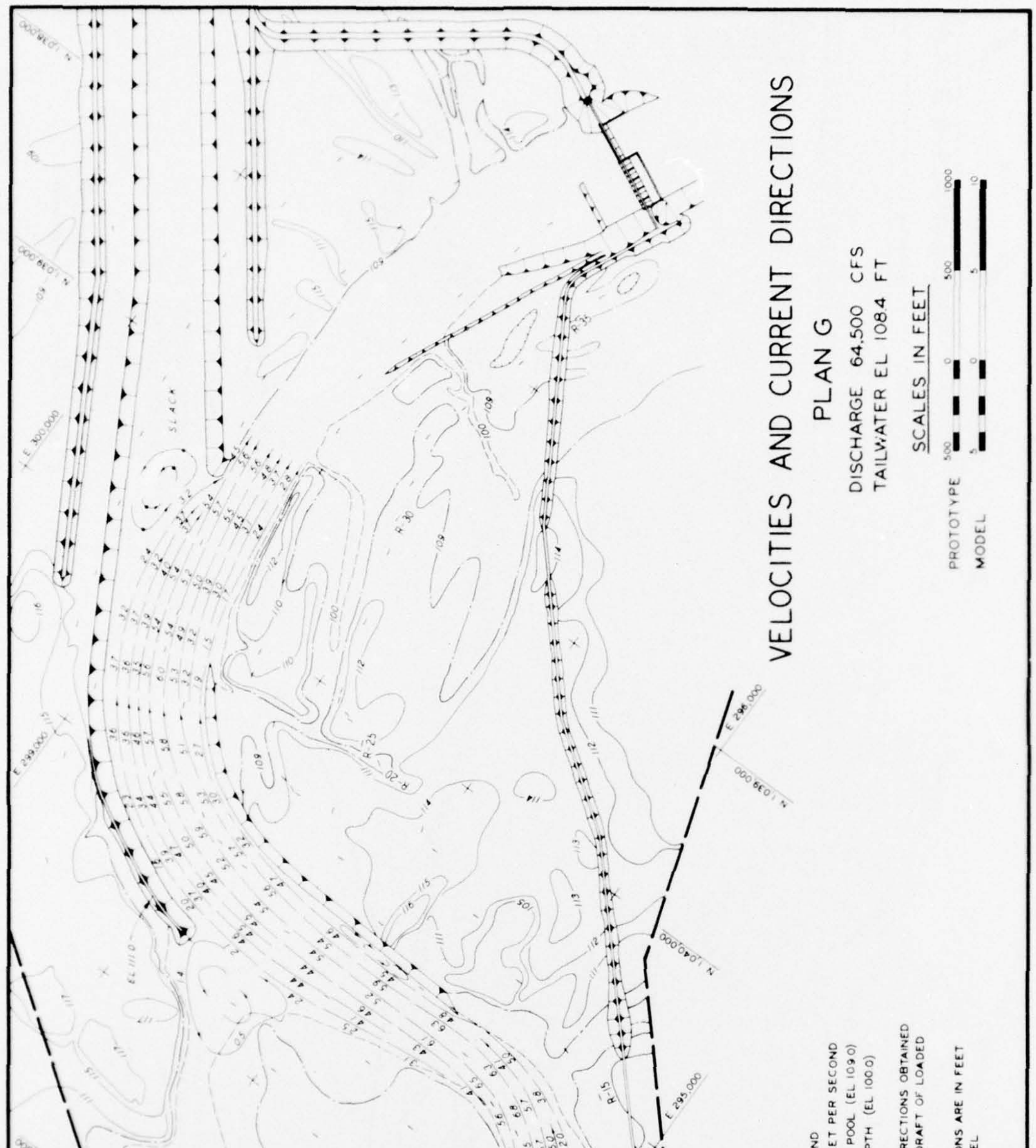
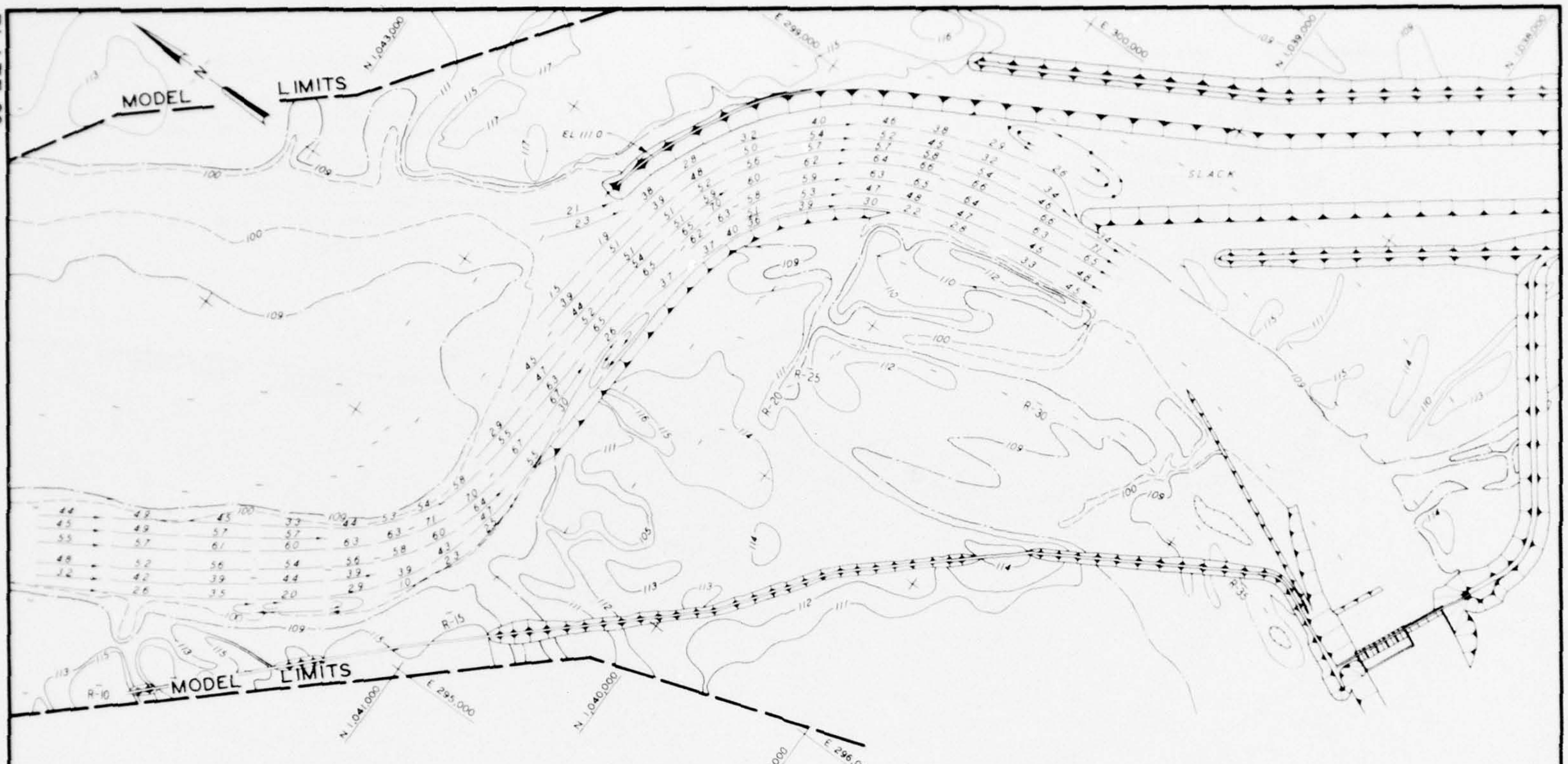

VELOCITIES AND CURRENT DIRECTIONS
PLAN G
DISCHARGE 64,500 CFS
TAILWATER EL 1084 FT
SCALES IN FEET
PROTOTYPE 500 0 500 1000
MODEL 5 0 5 10
LEGEND
4.2 VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
APPROXIMATE NORMAL UPPER POOL (EL 109.0)
APPROXIMATE NAVIGATION DEPTH (EL 100.0)
NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (9.0 FT)
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO MEAN SEA LEVEL
MODEL LIMITS
MODEL LIMITS
SLACK
N
E 295,000
E 298,000
E 299,000
E 300,000
N 1,040,000
N 1,039,000
N 1,038,000
R-10
R-15
R-20
R-25
R-30
R-35
EL 111.0

PLATE 19



VELOCITIES AND CURRENT DIRECTIONS

PLAN G

DISCHARGE 97,000 CFS
TAILWATER EL 114.3 FT

LEGEND

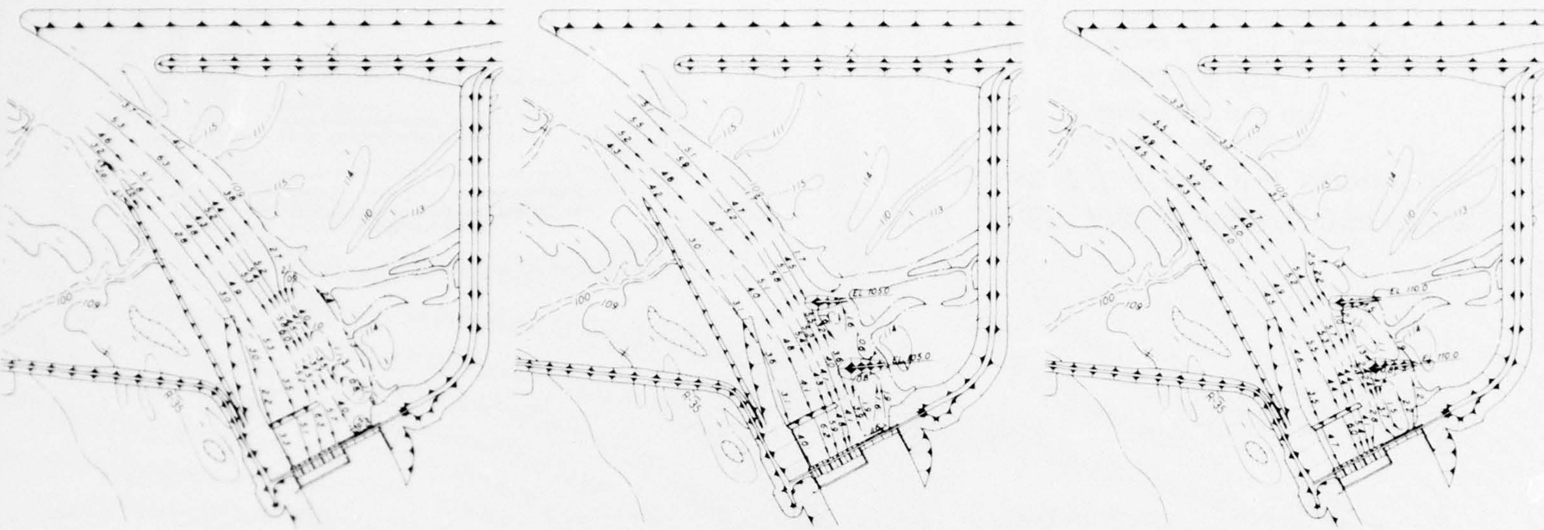
- 4.2 VELOCITY IN FEET PER SECOND
- VELOCITY LESS THAN 0.5 FEET PER SECOND
- APPROXIMATE NORMAL UPPER POOL (EL 109.0)
- APPROXIMATE NAVIGATION DEPTH (EL 100.0)

NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (9.0 FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO MEAN SEA LEVEL

SCALES IN FEET

PROTOTYPE 500 0 500 1000
MODEL 5 0 5 10



PLAN G

PLAN G-1
DIKES AT EL 105.0

PLAN G-1 MODIFIED
DIKES AT EL 110.0

LEGEND

- 4.2 VELOCITY IN FEET PER SECOND
- VELOCITY LESS THAN 0.5 FEET PER SECOND
- APPROXIMATE NORMAL UPPER POOL (EL 109.0)
- APPROXIMATE NAVIGATION DEPTH (EL 100.0)

NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (9.0 FT)

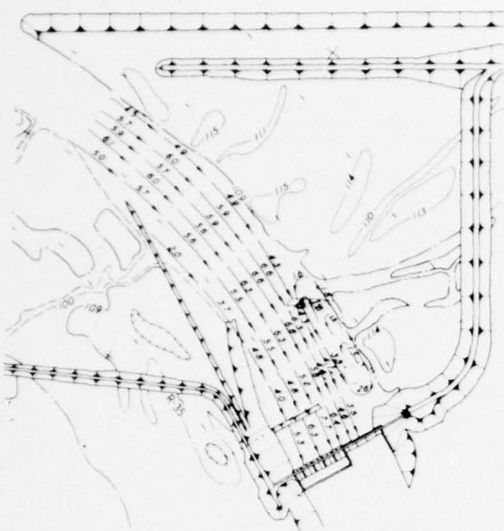
ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO MEAN SEA LEVEL

VELOCITIES AND CURRENT DIRECTIONS
PLANS G, G-1, AND G-1 MODIFIED

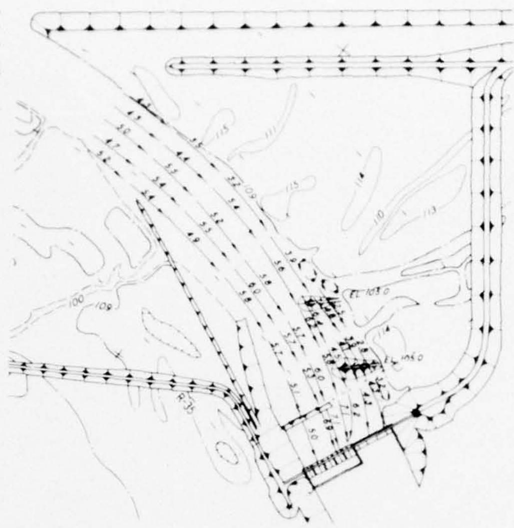
DISCHARGE 64,500 CFS
TAILWATER EL 108.4 MSL

SCALES IN FEET

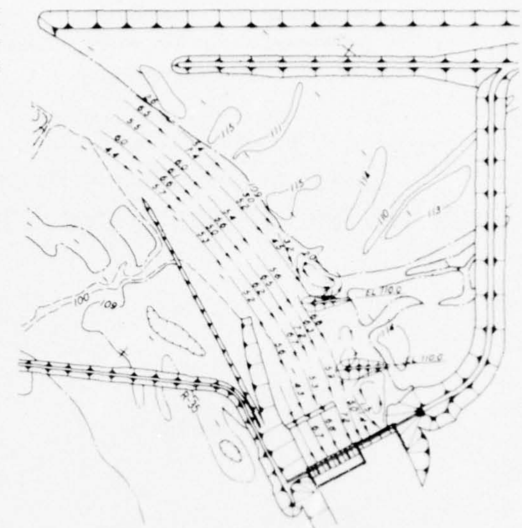
PROTOTYPE 500 0 500 1000
MODEL 5 0 5 10



PLAN G



PLAN G-1
DIKES AT EL 105.0



PLAN G-1 MODIFIED
DIKES AT EL 110.0

LEGEND

- 4.2 VELOCITY IN FEET PER SECOND
- VELOCITY LESS THAN 0.5 FEET PER SECOND
- APPROXIMATE NORMAL UPPER POOL (EL 109.0)
- APPROXIMATE NAVIGATION DEPTH (EL 100.0)

NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (9.0 FT)

ALL CONTOURS AND ELEVATIONS ARE IN FEET REFERRED TO MEAN SEA LEVEL

VELOCITIES AND CURRENT DIRECTIONS

PLANS G, G-1, AND G-1 MODIFIED

DISCHARGE 97,000 CFS
TAILWATER EL 114.3 MSL

SCALES IN FEET

PROTOTYPE 500 0 500 1000
MODEL 5 0 5 10

In accordance with ER 70-2-3, paragraph 6c(1)(b), dated 15 February 1973, a facsimile catalog card in Library of Congress format is reproduced below.

Shows, Louis J

Entrance to upstream approach canal, Gainesville Lock, Tombigbee River, Mississippi and Alabama; hydraulic model investigation, by Louis J. Shows [and] John J. Franco. Vicksburg, U. S. Army Engineer Waterways Experiment Station, 1976.

1 v. (various pagings) illus. 27 cm. (U. S. Waterways Experiment Station. Technical report H-76-19)

Prepared for U. S. Army Engineer Division, South Atlantic, Atlanta, Georgia.

1. Gainesville Lock and Dam. 2. Hydraulic models. 3. Locks (Waterways). 4. Navigation conditions. 5. Tennessee-Tombigbee Waterway. I. Franco, John J., joint author. II. U. S. Army Engineer Division, South Atlantic. (Series: U. S. Waterways Experiment Station, Vicksburg, Miss. Technical report H-76-19)

TA7.W34 no.H-76-19